THE SOUTH AFRICAN RAILWAYS

The South African Railways

HISTORY, SCOPE AND ORGANISATION

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Foreword

THE development of the State-owned South African Railways to their present-day position in the social and economic life of Southern Africa is, I believe, of interest not only to the citizens they serve, but also to students of transportation in other countries. The subject is a fascinating one. The Railways of South Africa in their comparatively brief existence have made valuable contributions to the science of transportation and, as the largest 3 *ft.* 6 *in. gauge system in existence, command a special place in the transportation world.*

The purpose of this book is to record and to present in a clear and easily accessible form the history and growth of the organisation which, in addition to railways, cover shipping, road motor services, ports and harbours, airways and a multitude of other subsidiary activities.

This is the first attempt ever made to provide a comprehensive survey of a State service whose progress in its impressiveness has matched that of a country which has changed from wagon wheel to rails of steel in little more than half a century. In the economy not only of South Africa, but even of neighbouring territories, the South African Railways have long played a dominant part. Their achievements in stimulating the opening up of a great sub-continent are perhaps not sufficiently appreciated.

Merely regarded as a financial enterprise it is by far the largest in South Africa, and it ranks among the great railway systems of the world. It is by far the largest single employer in Africa, with well over 170,000 *men and women, European and non-European, on its pay-roll.*

This book cannot possibly present every phase of the Administration's many-sided activities, nor can the whole of the romantic story be given. This survey is, however, more comprehensive than anything hitherto attempted and is designed to meet the needs of the general public as well as the research worker and student.

It is my sincere belief that this publication will achieve its purpose of placing on permanent record for South Africans and others interested in this fascinating country, the often romantic and always interesting history of the South African Railways.

F. Claud Sturrock

Mr. W. Marshall Clark, O.B.E., M. Inst. T., A.M.I.C.E.,
General Manager, South African Railways.

Preface

THE history of the South African Railways is the history of faith backed by well-directed pioneering; of periodic adjustments to changing economic conditions; of sustained technical progress in the field of modern transport; and of a successful State-controlled enterprise. The purpose of this book is to describe the undertaking, to give an outline of its historical development, and to present a compact picture of its many-sided activities.

The term " South African Railways " is an inclusive one, which is used—except where a more restricted meaning is clear from the context—to cover railways, harbours, shipping, road transport, airways and a host of subsidiary services.

In the Union of South Africa the co-ordination of public transport under a single administration, and not operated for profit in the ordinary commercial sense, is a cardinal principle of national policy. The State has, therefore, provided the entire capital and exercises absolute control of the South African Railways. While the latter have to pay interest on capital, and are required by law to balance expenditure against revenue, the service motive remains paramount. The shareholders are the public of the Union; the directors are the members of the Union Parliament.

In the economy of the Union of South Africa the Railways have a clearly defined place and with their ancillary services they are represented in every part of a country, which, together with South-West Africa, has an area of 790,219 square miles. One out of very eight of the European population of the Union is dependent on the South African Railways for a livelihood and transportation is the key industry.

In this account of the history, organisation and scope of the Railways, personalities have been avoided to a large extent and this comprehensive transport undertaking is presented against the background of a country which has compressed the development of centuries into the space of less than 100 years. In the last century South Africa has given the world gold, diamonds, other mineral wealth and many agricultural products. The South African Railways have had to keep pace with almost beanstalk expansion. That they have measured up to their exacting requirements is a tribute at once to the men who moulded the machine and to the enterprise of a virile population.

A subject as comprehensive as the South African Railways cannot adequately be brought within the compass of a single volume, but a sincere attempt has been made to present in proper perspective an objective picture of the largest single business enterprise in the Union of South Africa.

In the preparation of this book the Government Printer, the Department of Trigonometrical Survey and the Heads of all Railway Departments have co-operated. Their assistance, without which the task could not have been attempted, is gratefully acknowledged. To Mr. Eric Rosenthal, the South African author, who helped in the historical research, special thanks are due for enthusiastic co-operation.

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Chapter I

HISTORICAL BACKGROUND

LIKE the railway systems of most countries, that of South Africa is the indirect product of the great Railway Boom in England a century ago, but development in South Africa was hesitant and beset with difficulties. The secret of the country's wealth in gold still lay locked under the wind-swept ridges of the Witwatersrand ; Kimberley had not yet become a world synonym for diamonds ; and wild animals still roamed the veld which covered the coalfields of the Transvaal and Natal. From the population point of view South Africa was insignificant—there were no industries, not many large urban communities, and even agriculture was still in the early pastoral stage. The Cape of Good Hope was the only part of the sub-continent known to the outside world, and civilisation had merely extended a few tentative tentacles into a hinterland of mystery and danger.

The steps which have led to the establishment of what is to-day one of the greatest State-controlled systems of transportation in the world can be retraced for more than a hundred years. As far as can be discovered the very first reference to the question of railway construction in South Africa was made in the *South African Commercial Advertiser* for October 10, 1838—the year of the Great Trek from the Cape into the interior by dissatisfied subjects of British rule in the Cape Colony.

This paper, published at Cape Town, contained the following passage :—

The Railroad between Liverpool and Manchester cost an enormous sum of money—considerably more, we believe, than One Million Sterling. The annual expense of keeping it in repair, and the charge on the Steam Carriages, is also very great. But after meeting all charges and paying the proportions handsomely, it was stated by Mr. Warburton in the House of Commons that " the Manchester and Liverpool Railway now yielded an advantage every year of at least £400,000 to the inhabitants of those two places ".

The rate of travelling on these Railways is from twenty to thirty miles an hour. It was thought at first by many, that time only would be saved, and this was considered worth the money. But it is now discovered that goods can be transported cheaper at the rate of twenty miles an hour, by these roads, than by the old roads at the rate of two miles, or two miles and a half an hour !

The average expense of laying down a Railroad in a difficult line is £25,000 per mile. In some cases it is as high as £40,000.

Interest in the question of the possible adoption in South Africa of this new means of transport continued to grow, and the next reference appeared in the *Pictorial Times* of London, October 25, 1845 :—

CAPE OF GOOD HOPE WESTERN RAILWAY.

The first Meeting of the Provisional Committee was held on Friday, the 17th instant—Harrison Watson, Esq., the eminent Cape Banker and Merchant, in the Chair.

This Railway is calculated to be of immense benefit to this flourishing Colony ; and, as it is confined to the more populous Districts in the neighbourhood of Cape Town, the enterprize is certain to return ample remunerative profits to the Shareholders.

A few days later, on November 12 of the same year, the London *Morning Chronicle* had a further announcement :—

CAPE OF GOOD HOPE WESTERN RAILWAY.—NOTICE.—The Committee of Management beg to inform the public that the LIST for APPLICATION in the above Company CLOSED on the 31st ult., and that NO FURTHER APPLICATIONS can possibly be attended to.

By order, CHARLES JOHNSTON, Sec.
Office, 26 Moorgate Street, Nov. 6, 1845.

The immediate reaction at the Cape was, however, by no means favourable. For some reason the promoters of the enterprise had mentioned as their legal adviser the celebrated Attorney-General of the Colony, the Hon. William Porter, and the latter, on reading a reprint of the overseas announcement in the local press, addressed a letter to Mr. Johnston :—

To Charles Johnston, Esq.
Sir,

I have this day received your note of the 12th November, 1845, apprizing me that, at a Meeting of the Managing Committee of the Cape of Good Hope Western Railway, I had been appointed standing Counsel of the Company at the Cape.

I feel obliged by the compliment which the Committee, I have no doubt, intended to bestow.

But I cannot consent to have my name, however humble, in any way connected with a scheme which I regard as hopeless ; and believing the projected Railway to be a scheme of that description, I have the honour very respectfully to request, that you will move the Managing Committee to withdraw my name from their advertisement.

I have the honour to be, Sir,
Your very obedient Servant,
Wm. PORTER.

Whether it was on account of the discouragement given to the idea of railway-building in South Africa by Mr. Porter, or whether it was the general reaction against such schemes which set in as a result of the slump on the share market, further progress hung fire for a number of years. Even the fact that railway operation had made a modest beginning at the other end of Africa, namely in Egypt between Alexandria and Cairo, in 1856, failed to stimulate enterprise save in a very sluggish fashion.

By a curious chance the very first line to be laid down in South Africa, as in England, was not operated by steam power at all. This ran along the side of the Durban Bluff in Natal at the beginning of the 1850's, and preceded the starting of locomotive haulage by a wide margin.

Attempts at stimulating railway construction, however, continued at intervals, and they took shape in 1853 with the formation of the Cape Town Railway and Dock Company. This was backed by a number of well-known local merchants and businessmen. It was provisionally registered at the beginning of the following year, the capital of £600,000 being divided into 30,000 shares of £20 each, 5,000 of which were reserved for the Colonial Government if it wished to take them up.

Three trustees were appointed for the shareholders—Edward Barnard, Crown Agent for the Cape of Good Hope in London ; Captain the Hon. G. F. Hotham, R.N., of Brighton ; and Harrison Watson of St. Peter's Chambers, Cornhill, London.

Only two of the nine directors were connected with South Africa, but the remainder included several with considerable experience of railway construction in other parts of the world. This applied particularly to Mr. G. Lathom Brown, who was appointed Managing Director.

According to its Articles of Association " the object of the Company is to introduce into the Cape Colony, a progressive system of railways, and to supply to its capital safe and convenient access and facilities for the reception and repair of shipping, the want of which has been so long and severely experienced as a serious prejudice to the commercial and agricultural trade of the Colony, and to the development of its natural resources "

What emerges from this " birth notice " of the South African Railways is that one of the principles which even to this day underlies its operations was envisaged from the very start, namely, the running of railways and harbours under a common management. This feature of consistency in development will be noticed again and again in the story that is to be told. Even the principle of state ownership was already allowed for, at any rate in part, by the earmarking of a large block of shares for the Colonial Government.

None the less the Cape Town Railway and Dock Company began operations in a very humdrum fashion. Its first meeting of directors

was held in March, 1854, when Messrs. John Henry Reid & Nephews, Attorneys for the Company (a firm still in existence) were instructed by the London Board to form a Local Committee. In due course the Hon. John Bardwell Ebden, Messrs. George Thompson and Thomas Watson of the firm of Thompson Watson & Company (still existent), Samuel Bushell and Edward Jenner Geran, were nominated.

Perhaps in memory of a similar incident in 1838, in which William Porter had figured, a letter was read received from the Surveyor-General of the Company, Mr. Charles Bell, " objecting to that part of the prospectus in which his name occurs, and from which it might be inferred that he approved of the line of the road ". In spite of this, however, it was reported that 6,753 shares had been applied for, representing a capital of over £135,000.

By the time the second meeting was held plans for railway expansion and requests for new lines, to this day a never-ending source of discussion in South Africa, had already been put before the directors. A letter was put in " asking for the construction of a railway in Namaqualand for the conveyance of copper ore from the newly-discovered mines ".

As might be expected, the forthcoming arrival of the Iron Horse in Southern Africa was a subject of intense interest to the Colonists, and the recently-established House of Assembly appointed a special " Railway Committee " to examine the question of the Treasury guaranteeing interest on the money to be invested on the building of lines. A deputation from the Company waited upon the Governor on July 27, 1855.

By this time the Cape Town Railway and Dock Company had made its choice of its first Construction Engineer, William George Brounger, one of the great African pioneers whose memory has been unjustly overlooked. Brounger was born on June 26, 1820, at Hackney, and after an education at Totteridge and London University, became a pupil of the celebrated Victorian engineer Sir Charles Fox. Mr. Fox (as he still was) happened to be busy on the construction of the vital " London and Birmingham Railway ", forerunner of the Midland line, and Brounger distinguished himself by his innate ability.

In 1851 the firm of Fox & Henderson was put on to the construction of the Crystal Palace, which was to house the world's first international exhibition. Writing after the event Joseph Gwilt said in his " Encyclopedia of Architecture "—" The symmetry and strength of this vast building depended on the accuracy with which a simple plan was drawn out, and much credit is due to Mr. Brounger, who superintended this part of the work ".

From the Crystal Palace the young man was sent by his firm to Denmark, where he built one of the first lines, known as the Zeeland Railways, from Roskilde to Korsör. On the strength of this Sir Charles Fox, as consultant to the Cape Town Railway and Dock Company, put forward Brounger's name as " Engineer, Surveyor and Supervisor of Construction ".

The first line to be proposed in South Africa was to run from Cape Town to Wellington, a small but important centre in the wine-growing districts of the Western Cape of Good Hope, 45 miles distant. This, however, was merely regarded as the forerunner of a far more ambitious system which would ultimately link up all parts of the country.

One of the most remarkable instances of foresight at the earliest stage of development was provided about the same period by a former schoolmaster named John Patterson, who incidentally became the founder of the Standard Bank soon after. In 1855, Patterson, who was living at Port Elizabeth in the Eastern part of the Colony, put forward a scheme for a railway from that harbour to Graaff-Reinet, and in that town in 1857, he issued a pamphlet with a map, locally engraved in very crude fashion, on which was shewn a network of hypothetical railways covering South Africa, which differed only slightly from that which

developed during the 90 ensuing years. This is all the more impressive since neither diamonds nor gold, the prime movers of railway progress, had been discovered at the time.

As so often happens practical difficulties delayed the laying of the line from Cape Town to Wellington for a considerable time. Interviews and correspondence dragged on and it was not until April 16, 1857, that a Select Committee was appointed to review the entire position. Under the Chairmanship of the Colonial Secretary this body heard evidence and made a very conscientious report.

In going through the record one is surprised to find how accurately for the most part the pioneers foresaw which way the railway system of South Africa would develop. One sees requests for trunk routes from Cape Town to the interior, from Port Elizabeth to the interior, from newly-founded East London to the interior, and from the Kowie, soon to be known as Port Alfred, to its back country. Even though there were no major centres of population in the uplands of South Africa, which had only recently been penetrated by the emigrant Boers from the Cape, the outline of the future transportation system was taking shape.

Meanwhile a rival for the privilege of building the first line from Cape Town to Wellington entered the field in the person of Mr. Scott Tucker, Civil Engineer. The nature of his proposition was made clear in his evidence when he was examined by the Select Committee on May 29, 1857 :—

Chairman : With reference to your letter to the Colonial Secretary, dated 27th May, are the Committee to understand that you have come out on the part of a company, definitely to undertake the construction of a railway, or only for inquiry and information ?—I have been commissioned by some capitalists in England to visit the colony, with a view to learn if a Government guarantee could be obtained for the construction of railways in the colony, so that if a guarantee is obtainable upon a satisfactory estimate, a company would be forthwith formed in England for the purpose of immediately carrying it out.

The rate of interest contemplated was high by modern standards, even though it was reduced to 6 per cent. later. Most of the railways of the world were then being built by private enterprise with Government guarantees, and a memorandum submitted to the Committee showed that some enterprises received as much as 8 per cent. from the State.

Although the Committee regarded his scheme so favourably that it made the following recommendation :—

That His Excellency the Governor should be requested to introduce a bill into Parliament, guaranteeing interest at the rate of 6 per cent. on a sum not exceeding £500,000, for the construction of this railway and authorising His Excellency to enter into arrangements with the Company for that purpose, upon the basis of Mr. Scott Tucker's proposal;

the response to the appeal for tenders in England was disappointing. Despite the Act of June 29, 1857, in which the requisite guarantee of 6 per cent. was furnished, it was decided to start afresh, and this time the long-neglected Cape Town Railway and Dock Company received its chance.

On August 6, 1858, the contract for the building of the first railway in South Africa was awarded to this concern " on the basis of a guarantee from the Colony of 6 per cent., on a sum not exceeding £500,000, for 50 years from the opening of the line ; the Colonial liability being limited to £30,000 per annum ". No time was lost in starting the works but, through the delay resulting from the negotiations, the glory of opening the first successful line was snatched from Cape Town to another part of South Africa. Not the west but the east of the Cape Colony was first in the field.

Mention has already been made of the harbour at the mouth of the Kowie River, which was meant to become one of South Africa's major ports. Dredging and other coastal improvements were undertaken over a period of many years, and a total sum of around £800,000 was expended before silting up and similar factors put an end to these ambitions.

Construction began in the middle fifties, and a line was laid down for about a mile on the banks of the Kowie River. A locomotive was imported from Britain to haul the small trucks carrying the blocks of concrete and the loads of stone. This locomotive was running in 1859, and probably earlier still. It went out of use when construction work stopped and was left standing in a little shed on the west bank of the Kowie. Here it survived until well into the twentieth century, when it was tipped over into a " grave " constructed next to it, and buried. Perhaps it may yet be disinterred and restored to the honour which is its due.

Enterprise was in the air and the settlers of Natal, the younger colony on the shores of the Indian Ocean, were eager to take advantage of modern progress. The *Natal Mercury*, published in Durban, issued a leading article on January 20, 1859 :—

> We are happy to announce that a project is on foot, under the auspices of an eminent practical engineer, at present in the Colony, for constructing a railway, with locomotive steam power, between the Point and the town, through the bush and along the principal street thoroughfares. The great width of our streets renders this practicable without injury to general traffic. We believe it is intended to form a company for this undertaking.

Within a fortnight the " Natal Railway Company " had issued its prospectus, and on February 3, 1859, the *Natal Mercury* published the news that Durban alone had subscribed nearly half the capital. In scale the project was much smaller than the Cape Town–Wellington line, for the route was not much more than a mile in length. Dividends, however, promised to be on the generous scale of 30 per cent. per annum.

Advised by Mr. A. Robinson, the Engineer, the provisional directors, R. Acutt, Adolf Coqui, George C. Cato, J. Proudfoot, G. H. Wirsing, and W. Smerdon (Chairman), proceeded in a novel way to buy a supply of fuel for the engines, before the line had been laid. " The Directors " said the *Mercury*, " have already made a purchase of wood for the purposes of the railway, a favourable opportunity having offered, and they are prepared to have the line cleared without delay. There is no need to wait for the Act of the Legislature, as there can be no opposition, and the capital will be readily subscribed. " The prospectus gave an outline of the programme :—

> This railway and the other operations contemplated by the Company, are the more essential now that a steam tug is to be placed on the station, which, whilst obviating a recurrence of the frequent detention of vessels, will combine, when the jetty is completed, to make the harbour the most efficient in South Africa, and bring a large amount of passing tonnage to the port, Natal being situated directly on the route from India. It is contemplated eventually to extend the line beyond Congella to the Umhlatuzan, whence stone for the Harbour improvements can be procured, where wagons to and from Pietermaritzburg can be loaded, avoiding the whole of the heavy pull through the Berea sand, and where the growing sugar estates near the Isipingo, Umlasi, and beyond, promise a large amount of traffic. There is not a member of the community but will benefit either directly or indirectly by the opening up of railway communication in Natal, of which this is but the forerunner.

On February 28, 1859, representatives of the capital, Pietermaritzburg, were added to the Board, namely, Jonas Bergtheil, J. Henderson, and C. Behrens, and it was reported that " the line of the railway is already staked off and active operations are proceeding ".

By December 1, the news was that the material for the line was on the way, " so that if the directors do not still further cause delay by a bootless pertinacity respecting the site of a terminus, the railway will be opened for traffic early in the year ".

Four months later there was fresh and gratifying news. " Under the energetic superintendence of Mr. Tatham ", wrote the *Natal Mercury*, " aided by the co-operation of the Chairman, this work is rapidly progressing towards completion. The line is already laid half the distance and in a fortnight, if circumstances continue favourable, the rails will have been laid up to the final termination

near the church . . ." " Six or eight trucks and two travelling cranes are already mounted and in use. The locomotive is in the ' Cadiz ', so that all the materials will soon be received. "

The original locomotive, which was formally put into use on June 25, 1860, is today standing at the main station at Durban, after having been lost for many years and recovered in sections near Port St. Johns.

An official eye-witness, in describing the opening of Natal's first railway, said :—

> With a prolonged wailing shriek Jacobs turned on the steam, and the first train moved off amid the deafening and prolonged cheers of the assembled spectators. Gathering speed as he cleared the Engine House, he ran smartly down to the Point, which he reached in about five minutes. The crowd of natives hurled back a deafening yell, and started in pursuit, while a number of well-mounted young Dutchmen, who knew a thing or two, decided to test the bottom of the Iron Horse, so put spurs in their quadrupeds and successfully headed the train until it reached Stanger Street, when it was declared to have bolted round the corner into the bush, screaming at them as it ran . . .
>
> The band and the public squeezed themselves into all the available trucks, and a kind Providence with Engineer Jacobs watched over their departure when full up. After the first rush the traffic assumed a more deliberate form, but I continued to run up and down all day as fast as circumstances admitted, and it was computed that we conveyed fully 800 people to the breezy delights of the Point on this memorable occasion.

One of the officials of the Natal Railway, Mr. George Russell, preserved some extracts from his diary which gives an indication of conditions in those days :—

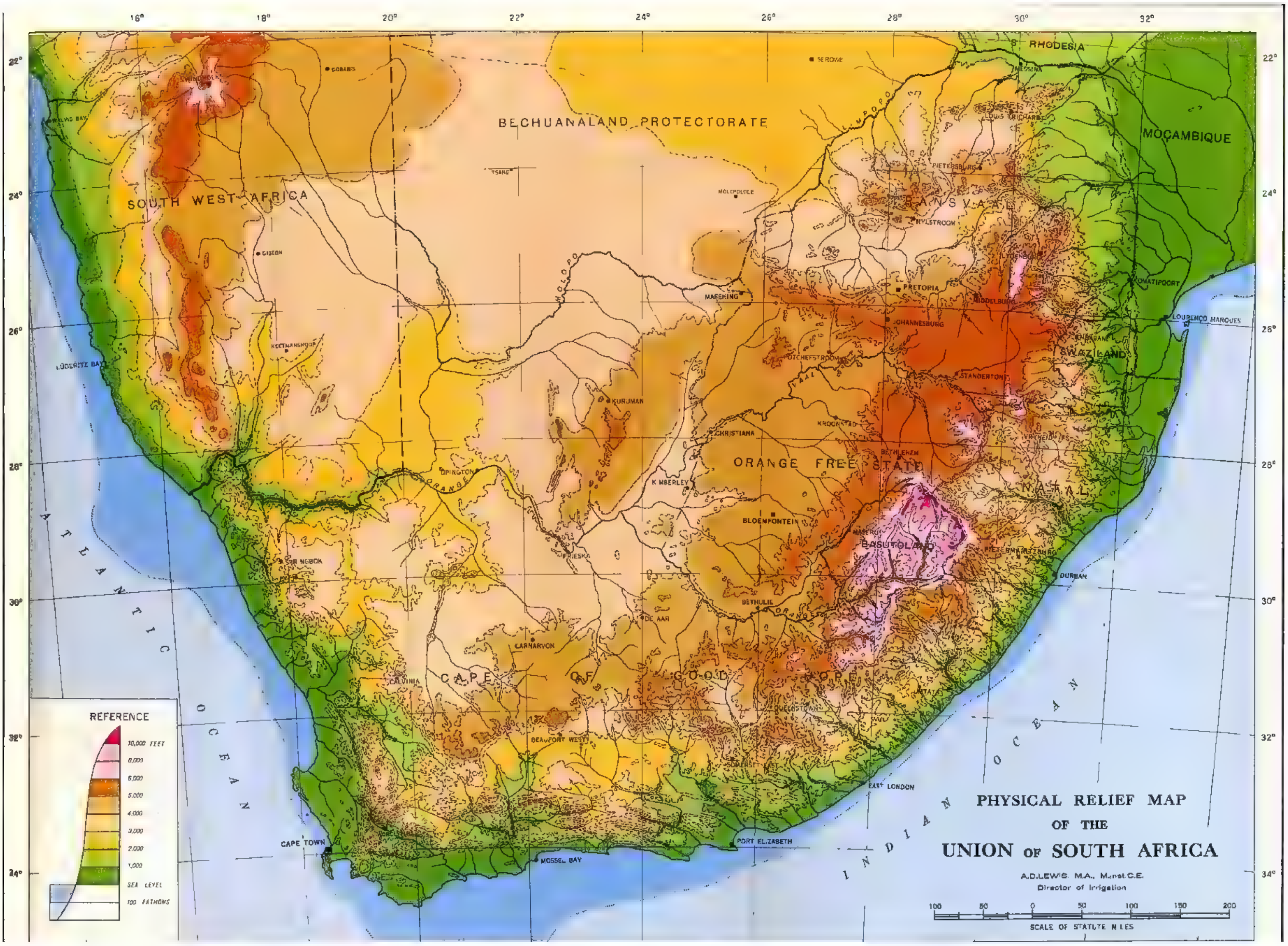
July 2nd. Commenced receiving and delivering goods. Contractors' carts more than we could supply.
23rd. Cold drizzling day. Strong S.W. wind. Expected Jacobs would not run the train, but he did, and earned 11s. with passengers.
25th. A great railway event to-day. For the first time trucks came up from the Point empty, with news that the Point was " cleaned out "

Progress was, meanwhile, being made on the line from Cape Town to Wellington. The first sod was turned on March 3, 1859, and trains began to run on the first section to Eerste River in February, 1862.

The full service did not, however, commence till November, 1863. By this time the country as a whole was alive to the advantages of railways and a new concern, established in 1861, under the name of the Wynberg Railway Company, started to build a line to that Cape Town suburb on August 14, 1862. Two years later, December, 1864, trains began to run for the public. Hundreds of miles on the other side of the Cape Colony, at Port Elizabeth, the enterprising local merchants and speculators were pleading for a link to the Interior. Financial and other handicaps, however, prevented them from achieving their ambition for another decade, and it was not till November 4, 1870, that a notice was published indicating that an application had been made to the Commissioners for the Municipality of Uitenhage, requesting that a grant of a piece of the common pasture land of this Municipality be made as a bonus to any company first constructing a railway between Uitenhage and Port Elizabeth.

Far inland, in the Transvaal Republic and in the Orange Free State, the Republican Governments were gradually being convinced that they too had to link up with the world by railway.

As early as 1860, a proposal was put forward by Sir John Swinburne, a relative of the famous English poet, for the running of a " road motor service " from the Portuguese settlement of Lourenco Marques on the Indian Ocean to the Tati goldfields in what is now the Bechuanaland Protectorate, to carry goods in trucks hauled by steam traction engines. A concession was actually granted for this purpose and the scheme was revived again in 1870, the use of steam being advocated because of the mortality of oxen from East Coast Fever and other diseases. In the last-named year O. W. A. Forssman and A. J. Munnick applied for a concession " for the building of road suitable for steam and other tractors, from the Portuguese border to one or other place within the Republic "


PHYSICAL RELIEF MAP
OF THE
UNION OF SOUTH AFRICA
A.D.LEWIS M.A., M.Inst.C.E.
Director of Irrigation
SCALE OF STATUTE MILES
REFERENCE
10,000 FEET
SEA LEVEL
100 FATHOMS
BECHUANALAND PROTECTORATE
SOUTH WEST AFRICA
RHODESIA
MOCAMBIQUE
SWAZILAND
BASUTOLAND
ORANGE FREE STATE
NATAL
CAPE OF GOOD HOPE
ATLANTIC OCEAN
INDIAN OCEAN
CAPE TOWN
MOSSEL BAY
PORT ELIZABETH
EAST LONDON
DURBAN
BLOEMFONTEIN
PRETORIA
JOHANNESBURG
KURUMAN
CARNARVON
BEAUFORT WEST
LÜDERITZ BAY
LOURENCO MARQUES
STANDERTON
MIDDELBURG
BETHLEHEM
GIBEON
GOBABIS

George Piggott Moodie, one of the discoverers in after years of the famous Barberton goldfields, succeeded in obtaining the first true railway concession from the Government of the South African Republic on August 26, 1872.

While President M. W. Pretorius had proved helpful, his successor President T. W. Burgers exerted himself even more to realise this scheme for a line from Mocambique into the Transvaal. The major difficulty under which both republics laboured was the smallness of their population. Between them they had barely 20,000 whites, and most of these had very little money. The entire revenue of the Transvaal was £73,862, and the Orange Free State £84,282, so that there was no question of guaranteeing interest on any loan, as the Treasury of the Cape of Good Hope had done.

Eager, however, to develop the resources of his country, President Burgers, a clergyman of high education and attainments, resolved to go to Europe in order to raise funds. Approval was given by the parliament of the South African Republic, the " Volksraad ", for the raising of a loan of £300,000, estimated to be sufficient to finance the construction of a line up to the frontier. Unfortunately lack of experience caused the scale of operations and the difficulties to be completely under-estimated. Mr. Hall, the railway engineer, who was instructed by President Burgers to examine the route, showed that even the fundamental figures were wrong.

" My survey has exceeded your Honour's instructions, in as much as it has extended to a point within the Drakensberg instead of terminating at the foot of the mountain—consequently the expense of constructing the railway up and into the Interior has raised the average cost per mile probably far beyond your Honour's expectations . . . An estimate of the probable cost at which the proposed 106 miles of railway may be constructed is £423,470, or at about £4,000 per mile ," he reported.

When President Burgers reached Amsterdam, he found the bankers there not keen on subscribing for such a hazardous venture in Africa. The total raised was £93,833, but undeterred the President proceeded to buy, mainly from the well-known Belgian firm of Cockerell at Seraing, railway material which was duly shipped to Lourenco Marques. The outcome was that the rails, girders and equipment were left to rust away on the beach at this Portuguese harbour.

In spite of this the Transvaal did not give up hope. On June 5, 1876, the Volksraad imposed a " Railway Line Tax on all quitrent farms to the amount of £1. 10s. 0d. each per annum ", and out of this modest sum they hoped ultimately to pay for construction. For many years before a single rail had been laid, the Railway Tax continued to figure in the Transvaal budget.

The Discovery of Diamonds.

By now a new age had commenced. Already in 1867 diamonds had been discovered at the Cape near Hopetown, and three years later the ever-spreading communities of diggers erupted into the new city of Kimberley.

Figures tell the story of the effect of these happenings upon railway construction. Practically no growth had taken place from the time when the routes from Cape Town to Wellington and from Cape Town to Wynberg were thrown open. The total distance was 65 miles, and so it remained for 12 years, when the discovery of diamonds caused construction to take a great leap forward. Since revenue for the Colonial Treasury had shot up from £617,826 in 1867 to £1,213,757 in 1873, the Government decided that the time had now come to exercise its power to expropriate the private companies (the Wynberg line had been leased for operating purposes to the Wellington Company).

The option vested by law in the Treasury was exercised and after doing sound pioneering work, the Cape Town Railway and Dock Company, as well as the Wynberg Railway Company, ended their existence. Instead, the

newly-acquired enterprises were placed under the Department of Public Works until growth of traffic and turnover prompted the establishment of the Cape Government Railways.

In Durban the Natal Railway Company continued operations until the latter seventies, when the Government decided to follow the example of the Cape, and to set up a system of its own. The first section of the line destined to run from the coast to Pietermaritzburg was placed in operation in 1878. Not for a long time did the Transvaal and the Orange Free State figure among the railway operators. This was not for lack of trying, although reactionary and conservative forces remained in existence there for a considerable time.

As late as 1887 " Anti-Railway Conferences " met at Ladybrand, Dewetsdorp, and Brandfort in the Orange Free State, at which, according to the well-known local statesman Sir John Fraser, such arguments were used as : (*a*) All railways are unnecessary ; (*b*) they are detrimental to transport riding by wagon ; (*c*) they are injurious to horse-breeding ; (*d*) they are likely to entail heavy land taxes ; and (*e*) they will encroach on property rights.

None the less, the majority of Burgers realised that the day of the ox-wagon was rapidly ending, and that they had to prepare for new methods of transport.

The most important change which followed the taking over by the Cape Colonial Government of the original railway companies was the adoption of the 3 foot 6 inch gauge instead of the " broad gauge " of 4 foot 8½ inches, which had previously been in use and which had been copied from the English model. Many questions have been raised why this was done, and the matter will be dealt with in detail in a later chapter.

Soon the practice adopted in Cape Town was also followed in Natal, and by tacit agreement the narrower gauge became almost universal, not only in Southern Africa, but in the north of the continent as well. (In Germany the expression " Kapspur " or Cape gauge has become synonymous with the 3 foot 6 inch standard).

Space is lacking to describe in detail the manner in which the railway system of the Cape now expanded, mainly in consequence of the discovery of diamonds. One of the most important works was the crossing of the Hex River Mountains into the Karroo, the preparation of which demanded most careful surveys and anxious consideration by the engineers. Originally the task was taken in hand by Mr. W. G. Brounger in 1873, the immediate terminus being Beaufort West, 240 miles from Wellington. A sum truly enormous by the standards of these times, namely £1,390,000, was voted for the job.

An idea of the methods used by the builders may be gained from passages in the correspondence between Mr. Brounger and his field engineer, Mr. Wells Hood :—

SIR,

Your first duty will be thoroughly to examine the country by visits with a view to determine the best route in an engineering point of view, without restriction as to starting point, that is to say, it may be any one beyond Tulbagh Kloof on the sanctioned line, which will offer the greatest advantage in respect of obtaining the shortest and best route to a point to be arrived at.

Mr. Maltby will accompany you as an assistant in this inspection. Your inspection, should, without limiting you as regards any others, at all costs include Ceres, Hex River, and Cogmans Kloof.

A month later, in March 1874, Mr. Wells Hood was in the field and his report reached the Head Office :—

I beg to inform you that I have thoroughly examined the country between Worcester and Grootfontein, both by Hex River Mountains and the Ceres routes. I am now fully convinced that there is no comparison to be made between these from an engineering point of view. After spending four or five days on the Hex River Mountains, and after very considerable climbing about, I have found a route that I may say gives every facility for the construction of a cheap railway.

The entry of the Iron Horse into the Karroo,

the great upland plain of the Cape of Good Hope, marked an epoch in African railway construction. Now the interior lay accessible, and it was only a matter of time before the first locomotive would enter Kimberley. What is more, the Eastern Cape System, as yet unlinked with its counterpart based on the west of the colony, was moving steadily inland.

In 1875 there were 154 miles open for traffic in the Colony. A year later the figure was 247 miles. This grew to 404 miles in 1877, and again to 562 miles in 1878. Every month, almost, brought fresh extensions during this busy period. No less than 240 miles were completed in 1879, bringing the total to 802 miles, and this again shot up to 913 miles in 1880. Disorganisation produced partly by the First South African War between Britain and the Transvaal Republic, and partly by a great slump in the diamond industry, slowed down progress in 1881 when only 55 new miles were finished, raising the total to 968, while in 1882 an even more modest eight miles were all that could be added. Leeway was, however, made up in 1883 when 245 miles—a record figure—were opened. This marked the completion of the first thousand miles in the Colony and the final figure for the twelve months was 1,221 miles.

In 1884 there were 1,506 miles in the Cape, and in 1885, 1,654 miles. This year saw the long awaited completion of the route to Kimberley. No change in the network controlled by the Cape Government took place from 1885 to 1888, and even in 1889 only nine miles were opened. However, by 1890 the Cape Government Railways covered 1,780 miles, and in 1892 the figure very appropriately reached 1,892 miles. This hardly changed till the second South African War. In 1899 there were only 2,001 miles. With the coming of the Twentieth Century a fresh spurt of building set in which brought the total in 1909, on the eve of the establishment of the Union of South Africa, to 3,329 miles in the Cape.

Apart from the effect of the diamond discoveries, another mineral helped to cause South Africa's railways to expand. This was coal. The first discoveries had been made at the Cape in the formation of the Stormberg Mountains in 1859, and modest attempts at exploitation had begun in the early sixties. Unfortunately, however, igneous action in bygone geological ages had burnt out much of the best grade, leaving a remnant with high percentages of ash and sulphur. Although the coal from Cyphergat, Molteno and Indwe continued to be used by the railways, it was only as a stop-gap, and for most serious purposes Welsh coal had to be imported. It was this which led the German traveller, Dr. Gustav Fritsch, to write as recently as 1886 :—

> There is probably no country under the sun, where adequate deposits of coal would prove such a blessing as in South Africa. What varied wealthy treasures remain useless ballast in South Africa, since the high cost of transport as well as all means of conveyance eats up their value ! Once they were supplied with cheap coal found in the country itself the railways, so sparse at present, which for the most part crawl along the coast, would boldly steam towards the interior of the continent, machinery would be able to supplement inadequate supplies of labour in the most gratifying fashion, and a stronger vegetation would, within a few decades, again adorn the terribly bare hills which are being stripped even of their most miserable scrub, because there is inadequate fuel.

Dr. Fritsch, who was a scientist of note, was not by any means optimistic on this point. " I regret to say, " he adds, " that despite all hopeful expectations and numerous samples which inspired little confidence, no payable beds have been found in these districts to my knowledge. Without disputing the existence of smaller coalfields in some districts, I must express the fear that such formations are of no considerable size in South Africa ".

It is rather strange to find a mention by Dr. Fritsch of the discovery of coal in the Klip River district of Natal which received the following comment:—" These beds so far appear to be of no practical value ".

Coinciding almost exactly with the discovery

of the goldfields of Bechuanaland and the Witwatersrand in the Transvaal came the finding of what proved to be some of the world's largest coalfields. The Klip River area led on to still greater deposits in the Transvaal. Such areas as Boksburg (now almost worked out) and Vereeniging, were suddenly able to supply the needs, not only of the neighbouring goldmines but also of the railways. Here, however, it will be necessary to return for a moment to an earlier phase of African railway development.

Mention has already been made of the various pioneer schemes in the Transvaal, including those for the operation of traction engines and of the abortive efforts of President Burgers to obtain finance in Europe.

Britain had decided in 1876 to place the struggling Republic under the Union Jack because it seemed unable to cope with the problems of independent statehood. While this new regime was in operation little was done towards carrying any further the scheme for a line to the Indian Ocean, although the Natal System was slowly advancing towards the barrier of the Drakensberg Mountains.

The restoration of independence to the Transvaal after the successful campaign of the republicans, which culminated in the victory at Majuba in 1888, brought with it a revival of interest in the establishment of steam transport. This time, however, nationalism had been stimulated and the rulers of the restored republic, headed by President Paul Kruger, proved most anxious to have an outlet which did not pass over British soil. This lay available at Lourenco Marques, comparatively nearby, and sited on the shores of the great land-locked Delagoa Bay. Although not too distant, the presence of fever and other troubles, mainly financial, continued to be a very serious obstacle. The first glimpse of daylight for the harassed Transvaalers came with the discovery of gold in the valley of De Kaap in 1884 and on the Witwatersrand in 1886. From now on their treasury was no longer in constant peril of bankruptcy and President Kruger could play a much more effective hand in the diplomatic game. The concession-seekers and speculators were recognising the possibilities of profit if only the "Delagoa Bay Line" could be built.

One of the first in the field was Col. Edward McMurdo. An American, he had fought in the Civil War on the Northern side, but after the return of peace decided to try his fortune in fever-stricken East Africa. Here he heard of the previous schemes of Forssman andBurgers.

Together with a Mr. Unger, McMurdo, convinced that the Portuguese would build their share of the line, in April, 1882, submitted to the Republican Government his petition for leave to construct a railway to the border. On May 3, the matter was referred to a special commission of the Volksraad. More urgent affairs, however, occupied its attention. Over a year passed. Then, on July 13, 1883, the Colonel's application was turned down. Completely discouraged, Unger withdrew from the transaction, but the American refused to give in. McMurdo himself left for England to raise money to construct the vital 60 odd miles across Portuguese territory, without which the South African Republic could never reach the sea. A man of some wealth and social prestige, he established his home in Charles Street, Berkeley Square, and, having the right connections, managed to arrange contacts with Lisbon. Meanwhile Meneer Beelaerts van Blockland and Meneer D. Maarschalk, representing the Dutch concessionaires, set forth in May, 1884, for that city, where they were joined by the Colonel, who rushed over from Amsterdam.

Twelve thousand miles away—in Java—where Holland had many funds invested, a slump suddenly occurred. To the dismay of the American, his great scheme collapsed, because his backers had lost too heavily in the East.

Senor Fontes Fereira De Mellor, the Portuguese Prime Minister, was getting tired of the complicated deal, and threatened to cancel it when, at the last moment in 1887, McMurdo succeeded in floating in London the Lebombo Railway Company, called after a range of hills

on the frontier. German bankers, anxious to assist the overseas programme of Kaiser Wilhelm, offered the Colonel £700,000 for shares of a nominal value of £251,000, but so sure was the Colonel of his own prospects, that he turned down the bid.

The Netherlands South African Railway Company had meanwhile received the concession to build the line and was formally established on June 21, 1887. Its backers included the firms of Labuschagne Oyers & Company of Amsterdam ; Robert Warschauer & Company ; and the Berliner Handelsgesellschaft, the latter two of Berlin. Into their hands ultimately passed what was left of the McMurdo concession.

The Netherlands South African Railway Company met with such difficulties at the start that its hopes frequently ran very low.

" Throughout the fever season ", wrote the late Mr. Barry Ronan, who was himself on the job, " we all suffered heavily. At first we had no doctor, and had to fight the malaria with what limited knowledge we possessed. At that time Lourenco Marques was surrounded by a belt of swamp forty miles broad. If a spade turned up a foot of soil the overpowering stench of decayed vegetation explained why malaria was so prevalent. They have changed all that now, chiefly by the judicious planting of blue-gums in the vicinity of the town. But in my time the malaria was an ever-present menace, and took a heavy toll of the Europeans engaged on the railway construction. The total absence of even the most elementary sanitary arrangements was a staunch auxiliary of the fever fiend. One could almost see the tropical vegetation growing under the blazing sun. Then torrential rains flattened out the vegetation. When the rains ceased the sun steamed up the sodden mass and the atmosphere was a mist of malaria."

" I have said the toll we paid was heavy, and I believe it took some hundreds during the year I was there. The men from overseas, full-blooded men, went first. Hence originated the saying that a corpse lies under every sleeper of that line. Nothing was then known of malarial infection by mosquitoes. There were millions of those useless insects, but the pests were not needed, one inhaled miasma with every breath, and swallowed it with every mouthful of food. The most surprising thing to me was the various after-effects of the fever. It did not seem to affect two people alike, except in the cases of those who died suddenly from heart failure when apparently fully recovered from an attack. In my own instance it took me fifteen years to shake off the after-effects, which took the form of an ague, the attacks becoming less virulent as the years sped by. At first there was no doctor to attend to our cosmopolitan crowd, and in the hotel where I stayed there were at one time thirty delirious men with absolutely no attendance. There were two deaths of delirious men who wandered down to the beach, lay in the surf for coolness, and were washed out in the bay and drowned. Presently an Indian doctor arrived from Goa, who gave much relief, but his hands were too full to make his ministrations general. Later a European doctor appeared on the scene. He was a good fellow, and never spared himself in the performance of his duties."

Once the Highlands had been reached progress was more rapid, but in the meantime diplomatic factors complicated the position. The Cape of Good Hope had brought its railway line almost to the frontiers of the Transvaal. The route from Natal was likewise getting very near the Republic. The line from Port Elizabeth was at the southern boundary of the Orange Free State and, once it was carried through that country, it would provide yet a fresh means of access to the Transvaal.

Knowing that the Orange Free State was still too poor to finance so big an enterprise, the Cape Colony even offered to pay for the construction of a railway over the territory of its neighbour. This was the state of affairs which brought on an unexpected deadlock with President Kruger. To the dismay of the Railway enthusiasts at the coast he informed the Cape and Natal that he would not allow their lines to enter his country until that of the Netherlands South African Railway Company had been finished.

The conferences attended by delegates not only of the Colonies but of both Republics met repeatedly to straighten out the difficulties. After a period of hesitation the Orange Free State decided to accept the bid of the Cape to build the line, though it later preferred to operate it in its own name.

On the fundamental question of priority of entrance into the Transvaal President Kruger remained obdurate. His point of view was that the independence of his country in a large

measure depended on the maintenance of at least one outlet which did not fall under British control. Technical difficulties, as well as the prevalence of fever, slowed down the progress of the Delagoa Bay line much more than had been foreseen, and to make an already disturbed position still more uncomfortable the restless personality of Cecil John Rhodes hovered in the background, with his dominating plan for an " All-Red " route designed to link the Cape to Cairo.

The arrival of the railway in the South African Republic did not, however, have to wait until the line to the coast was finished. A small but in a way unique system was established on the Witwatersrand in 1890. In the words of one contemporary, it led from " nowhere to nowhere ". This was true in as much as it was not linked with any other railway system, but its termini were the gold-mining metropolis of Johannesburg and the (then) coal-mining centre of Boksburg, respectively. The distance was sixteen miles, and in order to overcome opposition on the part of die-hards in the Volksraad the concessionaires preferred to call it the " Rand Tram ". In fact the coaches and trucks were hauled by locomotives and it was a railway in everything but name. This line was opened for traffic in 1890 and was the first in the Transvaal.

According to an account issued at that time :—

> A steam tramway has now been completed, the Company having obtained from the Government the right of running over certain lands, and trains or trams are running between Boksburg and Johannesburg. The greater portion of the permanent way runs very evenly along the line of the Main Reef. The line is not a difficult one to work, for the attention of the engineers all along has been directed to the maintenance of an even way, with a gradient of one in a hundred, the steepest gradients in the Cape Colony are one in forty. The Boksburg terminus is situated close to the coal mines, the line enters the Government farm Vogelfontein, and passes on to the Witwatersrand Gold Mining Company which is the first great coal-consuming concern met with . . .
>
> A good stretch of land has been taken in for the purpose of the Johannesburg terminus ; but it has been capitally laid out, and already offices, workshops, passenger and goods station buildings have been erected. The offices are built of brick, and provide accommodation for the Company's chief servants, the whole being splendidly equipped. Near is the passenger station, consisting of several waiting-rooms, and quarters for officials. The large corrugated iron structure, which can be viewed from town, is the Company's chief workshop.
>
> Work on the Krugersdorp extension has been already commenced at five different spots, the object being to have the line completed with as little delay as possible. This section will be twenty miles in length.

That year the line from Cape Town reached Bloemfontein, capital of the Orange Free State, and was continued northward.

In response to the continuing pressure both from the Uitlanders who had settled in the midst of the Republican population on the goldfields, and by the British Foreign Office, President Kruger finally agreed to allow the railway line from the Cape to be continued to the Witwatersrand. In 1892 the first train from the coast reached the goldfields from Cape Town and within a few months the links were completed with Port Elizabeth and East London as well, through the prolongation of the route through the Orange Free State. Efforts for the completion of the railway to Lourenco Marques were redoubled, and the programme designed to reach points within the boundaries of the Republic was also pushed ahead. As a result, on November 2, 1894, the long awaited service of the Netherlands South Africa Railway Company between Johannesburg and Mocambique was opened. Fresh progress was made the year after when the final keystone in the country's transportation system was placed in position. The first train for Johannesburg left Durban on December 16, 1895. It was, however, a period of great political trouble. Anxious to build up the traffic on the Lourenco Marques line President Kruger's government authorised discriminatory rates, thereby exciting the anger, not only of the rival Cape Government Railways, Natal Government Railways and

Orange Free State Railways, but of all the diggers and merchants of the Witwatersrand. The latter promptly decided to boycott the lines of the Netherlands South African Railway Company. Goods were delivered at the frontier of the Orange Free State, ferried across the Vaal River, and taken by ox-wagon to Johannesburg. President Kruger countered by closing the drifts or fords. Britain and the South African Republic were perilously near war, and very soon Pretoria realised it. The ban on transport by ox-wagon was withdrawn, and a compromise arrived at which was reasonably satisfactory to the various parties. Up to the time of the South African War further progress was comparatively smooth.

During these years a fresh trunk route was being developed. It took off from the main line between Cape Town and Kimberley, carrying on due north and following in the wake of the " Pioneer Column " sent into Matabeleland and Mashonaland by Cecil Rhodes. The new territory which this statesman added to Queen Victoria's Empire, and to which was given the name of Rhodesia, received modern transportation at a surprisingly early stage.

In 1890 the Union Jack had been hoisted in Mashonaland. In 1891 Rhodes was already building the first railway from Beira in Mocambique towards the highlands of Manicaland and on towards Fort Salisbury. Almost simultaneously work began on the extension of the Cape System, first through Bechuanaland and then into Matabeleland to Bulawayo. By 1897 his ideal had come true, and the main settlements of the new country were in touch with the world by steam. Already his engineers were surveying the route further north to the Victoria Falls and the Congo.

The criss-crossing of South Africa's more obscure districts with a network of branch lines was being continued with few breaks. As the nineties advanced the Transvaal began to catch up in the extent of its system. There were 41 miles in 1890, and this had exactly doubled in 1891. The new figure of 82 miles shot up to 160 in 1892, to 237 in 1893, and again was nearly doubled in 1894 when it expanded to 416 miles. The year of the Jameson Raid saw the Transvaal with 573 miles of line, though progress was slowed down somewhat by its effects.

From 659 miles in 1896 the total mounted in 1897 to 702 miles, and again to 840 miles in 1898. At the turn of the century, when the Boer War broke out, the South African Republic possessed 881 miles of railway. It had surpassed Natal which now had 498 miles, and the Orange Free State with 442. Altogether South Africa in 1899 had 4,262 miles of line.

Although many people are inclined to stress the hardships of travelling in those days, it is worth noting that conditions had already vastly improved. Far-travelled men of the period endorsed this. Mark Twain wrote in 1896—" Several long journeys gave us experience of the Cape Colony Railways ; easy-riding ; fine cars ; all the conveniences ; thorough cleanliness ; comfortable beds furnished for the night trains . . . "

Not long after Winston Churchill gave his view—" Railway travelling in South Africa is more expensive but just as comfortable as in India. Lying-down accommodation is provided for all, and meals could be obtained at convenient stopping places. The train, which is built on the corridor system, runs smoothly over the rails—so smoothly indeed, that I found no difficulty in writing ".

The South African War produced many changes both in railway construction and in operation. At the outset the success of the Republican armies in invading Natal and the Cape of Good Hope, brought with it the surprising phenomenon of the Netherlands South African Railway Company extending the field of its management to Ladysmith, and to near Kimberley. As the tide of war flowed against the Republics the British army extended its sway. That distinguished engineer, Lieut.-Colonel Sir Percy Girouard, was appointed Director of Railways of the South African

Field Force. A Canadian by birth, his part in the development of South African transport has usually been overlooked. As a soldier in the Royal Engineers he had gained great experience in railway management and construction during the British campaigns in the Sudan, and he had also been Railway Traffic Manager at the Royal Arsenal at Woolwich.

From the moment the British forces gained control of the major network of the Orange Free State it was decided to establish a new organisation, which developed into the " Imperial Military Railways ", ultimately embracing the whole system of the Netherlands Company in the Transvaal.

As from June 1, 1900, this important organisation began to function and it continued its existence until July 1, 1902, when the lines were handed back to the Civil Government. Girouard, however, remained in control for several years more, during which time the Central South African Railways were established, forerunners of the South African Railways as they are known today. From 1902 to 1904 he was Commissioner of Railways for the two new colonies, and during this time numerous very competent officials and technical men were imported, mostly from Britain.

The Netherlands Railway Company went into liquidation and a great programme of reconstruction and overhauling was taken in hand to make good the damage done by both sides.

Depreciation in the Cape Colony and Natal grew very serious, mainly owing to reaction to the war-time boom, and formed a sharp contrast to the prosperity which increasingly descended on the Transvaal. In spite of this the building of railways never slackened during the years of slump and, in fact, construction reached record figures. Thus, after a complete standstill during 1899, the Cape completed 100 miles of line in 1900, 46 miles in 1901, 183 miles in 1902, and 197 miles in 1903. There was a slight drop to 148 miles in 1904, which soared to a record figure of 321 miles in the single year 1905. The setback showed itself first in 1906 when 206 miles were finished, in 1907 when it fell to 66 miles, and in 1908 when there were only 7 miles built. By 1909 construction again was on the upgrade and the Cape of Good Hope became a major partner in the railway system of the Union of South Africa in 1910, when it contributed nearly one-half of the then grand total of 7,577 miles.

The Transvaal, though it too had been very busy, had far less—namely 1,706 miles. Natal and the Orange Free State possessed systems of very nearly the identical size—1,043 miles and 994 miles, respectively.

With the establishment of the Union of South Africa, comprising the four once separate territories of the Cape of Good Hope, Natal, the Transvaal and the Orange Free State, the South African Railways came into being as a unit. Under the South Africa Act of 1909 " all Ports, Harbours and Railways belonging to the several colonies at the establishment of the Union shall from the date thereof vest in the Governor-General-in-Council "

For a while the Central South African Railways, Cape Government Railways and Natal Government Railways continued a more or less independent existence, but they were gradually merged together, and the final " marriage " took place in 1916 when a supplementary act provided " The Railways, Ports and Harbours of the Union shall be administered and worked under the control and authority of the Governor-General-in-Council to be exercised through a Minister of State, who shall be advised by the " Railways and Harbours Board." " The management and working of the Railways and Harbours shall, subject to the control of the Minister, be carried out by the General Manager who shall be governed by such regulations as the Minister may from time to time frame after consultation with the Board ."

Under the new system Johannesburg, as the major commercial centre of South Africa,

The Blue Train with Class 23 engine, in a typical setting, on its way north through the Western Province.

Eighty years ago the railway line over the Hex River Mountains was first surveyed. Now it is proposed to drive an eight-mile tunnel through the most formidable section. The blast is at the entrance to the new tunnel.

became the seat of the unified administration, and more will be said at a later stage in this book about the system of operations adopted.

The Union was only four years old when a severe time of testing came to the South African Railways. This was brought about by the outbreak of World War I which, as far as South Africa was concerned, was accompanied by a serious rebellion in the provinces of the Cape, Orange Free State, and Transvaal, followed by the campaign against the then hostile adjoining territory of German South-West Africa.

One of the most remarkable achievements in the history of the South African Railways was the manner in which, by furnishing sufficient mobility to the Government forces under General Botha, the Railways helped to bring about the collapse of the rebellion and soon after, by speed in building a connection between the South African and the German railway systems, made it possible to bring about the ultimate surrender in 1915 of the Kaiser's forces.

At the time when the war began in South-West Africa the nearest point on the South African Railways was at Prieska. This was extended to the frontier village of Upington—146 miles off—on the Orange River, at an average rate of 2¼ miles a day. Construction started on August 31, 1914, and the Border was reached on November 20, 1914. The record distance in a single day was 3¼ miles. A ferry was opened over the Orange River and the final link-up took place on June 25, 1915, at Kalkfontein.

In addition, the South African Railways produced munitions on a considerable scale for the South African forces, and helped out the economy of the country in many other ways. All this was done despite the heavy drain on manpower due to direct recruiting and to the despatch of railway units to outside theatres of war. After the return of peace a large programme of reconstruction was taken in hand, the most important new features being the commencement of the electrification of the line to Natal and the suburban system around Cape Town. In addition, a chain of grain elevators was constructed to serve the needs of farmers throughout the Union.

More recent developments are dealt with in greater detail later in this book, and it is sufficient to say that an unparallelled period of growth has followed the birth of the Union of South Africa. Not only has the mileage operated more than doubled itself (including the absorption of the former German lines in the now mandated territory of South-West Africa), but traffic and staff have reached a size incredible to the first-comers. Whereas in 1910 South Africa had 7,577 miles, the total today is 13,483 miles. This mileage is more than doubled if allowance is made for the vast network of road motor services which now operate over 22,000 route miles. Road services were first started at Germiston in 1907 with the use of primitive lorries and vans. Today they reach the most remote points in the land and involve the use of more than 2,000 vehicles.

Airways operation, already conducted by private enterprise, was taken over by the South African Railways on February 1, 1934, when the Union Government incorporated the former commercial company, which had been running successfully since 1928, as a new department of the Administration.

The development of harbours and lighthouses under the aegis of the South African Railways is a story on its own which has descended directly from the original programme of the Cape Town Railway and Dock Company.

With its history going back over a century, a capital investment of over £228,000,000, an annual revenue of around £75,000,000, and a staff of over 170,000, this greatest of African enterprises is, in the apt words of one writer " second only in size to the State itself "

Chapter II

THE 3 FOOT 6 INCH GAUGE.

THE course of development taken by the South African Railways has been mainly determined by two factors—the absence of navigable rivers in this continent and the existence of great mineral wealth deep in the interior.

Whereas the systems in Canada have in the main supplemented and linked up such mighty waterways as the St. Lawrence and the Great Lakes, and have consequently trended from east to west, and whereas the railways of Australia have, for the most part, been kept near the coastal zone because of the barrenness of the far interior, those of South Africa have been built up around a series of " iron spines " running inland from the main ports to the Diamond Fields, the Goldfields, and, in a lesser measure, to Rhodesia.

The importance of railway building in South Africa is also reflected in the relatively high mileage in proportion to its area. Even allowing for the desolate nature of Northern Canada and the deserts of Central Australia, it is noteworthy that the Union on March 31, 1940, had 17·4 miles of line per 1,000 square miles of surface as against 11·89 per 1,000 square miles in Canada and 9·4 per 1,000 square miles in Australia. The disparity becomes even more impressive when the area and mileage of South-West Africa is deducted from these figures. It then appears that the Union has approximately 24 miles of railway per 1,000 square miles of surface, which is far more than double the Canadian and Australian ratios. (While it would be unreasonable to over-emphasise the importance of navigable rivers in Australia it is none the less true that the Murray, the Darling and others provide facilities for traffic which do not exist in South Africa).

Planners of the first lines at the Cape were not slow to realise that the railroad provided a unique and inevitable method of making good Nature's deficiency. Pleas for lines were put forward with fervour even in the earliest days. The Hon. Alexander Wilmot, a member of the old Legislative Council of the Cape, declared in 1872 :—

The desire of obtaining railway communication with the interior became from time to time almost increased to a passion, when periodically recurring droughts threatened places far distant from the sea-coast with actual famine. Railways are required to bridge over tracts of countries where transport is sometimes absolutely impossible, as well as to provide facilities for the important and fast-increasing traffic connected with the Diamond Fields.

Statistics commenced to flow. In one case two wagons and twenty mules purchased in Cape Town for £450, took sixty-five days to carry 12,000 lb. to Klip Drift on the Vaal River. The freight charged was forty shillings per hundred lb., which gives some idea of the cost of bringing goods from the sea-board to the Diamond Fields. A Port Alfred railway was championed at a public meeting in Grahamstown by Mr. Heidemann, but the city was in favour of a line from Port Elizabeth also, and deemed it desirable to postpone all movement in connection with the Kowie until after the meeting of Parliament. At the same time Graaff-Reinet called out for a midland line, and declared that at this time it was doing a larger business than any other inland town in the Colony. In February (1872) Sir Henry Barkly visited " The Gem of the Desert " and declared, in reply to an address of welcome, that the Sneeuwberg Mountains had hitherto been deemed " an insurmountable barrier to going beyond Graaff-Reinet, and this is the first time, as far as I am aware, that it has been publicly asserted that they may be crossed in a northerly direction from hence, with easy gradients and at a very moderate expense "

Only the State was able to provide sufficient financial backing in a country with so small a white population as South Africa then possessed,

and even so it was mainly the wealth of London which made the ambitious projects possible.

Disadvantages were not lacking in the principle of state-ownership, but the good far outweighed the bad. Amongst the handicaps were the "political railways" about which Mr. Wilmot speaks, and from the burden of which South Africa even to-day is still seeking to release herself. Not only was the power of the voter exercised to attract branches to particular districts irrespective of economic considerations, but individual politicians were known at times even to have lines diverted so as to cross their own farms. It took time before these abuses were terminated, but, generally speaking, South Africa was fortunate from the very outset in having an exceptionally able and honest type of railway builder.

Mention has already been made of W. G. Brounger, who came to the Cape with a fine reputation from Europe and who spent the rest of his career in creating a system of which the country still is proud. He, in his turn, imported assistants and junior members of the staff. Most of them had been brought up in the tradition of British railway building. Some of them could remember the days of George Stephenson and his immediate successors. Honest craftmanship and thorough, if at times rough and ready training, were demanded.

As yet South Africa did not produce railwaymen of her own. Even the navvies employed on construction had to be brought out. In 1872 a shipload of 2,000 white men reached the Cape at a cost of £26,000, paid for by the Government. These and other immigrants helped substantially to increase the population. From the time of the first engine driver, William Dabbs, who not only drove but assembled the pioneer locomotive supplied by Hawthornes of Leith, the staff was recruited from abroad. Local workers, even natives, were only very sparingly employed. The Transvaal, with its desire not to rely too much on England, led the way with a policy of internationalism, and this was later replaced by a programme of increasing "South Africanisation" Of this aspect of development more will be said in due course.

The overseas tradition was responsible likewise for the adoption of the broad gauge. It did not enter the minds of anyone to depart from the 4 foot 8½ inch standard which was employed, not only in Britain, but in the United States and in Europe. It is difficult to determine who first started the idea of using a narrower width of rail, but the change was brought about by the increasing cost of development. Both the routes from Cape Town to Wellington and from Salt River to Wynberg had been laid with a 4 foot 8½ inch gauge. So had the line from the Point to Durban and from Durban to Umgeni, a total of six miles.

Mr. M. R. Robinson, Chief Inspector of Public Works, brought up the subject clearly when giving evidence in the year 1872 before the Cape Parliamentary Select Committee on railway purchase :—

> In the case of an extension there will probably be a break of gauge, and then one of two things must occur : Either we must have an intermediate rail laid for bringing our rolling-stock suited for a narrow gauge into Cape Town from Wellington, or we shall be subject to the expense and inconvenience of transferring our traffic from the broad to the narrow gauge, and *vice versa* . . . The intermediate line would be 3 foot 6 inches or whatever may be determined on.

The novelty of this proposal impressed the Committee but they did not see fit to make any definite recommendation, in which respect they differed from the legislators of Natal. Under the Government Railways Law No. 4 of 1875 it was laid down : "The railways shall be constructed of single lines on the gauge 3 foot 6 inches ; but the Lieutenant-Governor may from time to time cause double lines to be constructed at such places on the course of the said railways as he may think expedient".

The change-over at the Cape was only effected gradually. We find that in 1875 there were two different measures in use, as the extension beyond Wellington had been laid to the 3 foot 6 inch

gauge. A complicated system of loop lines between Klapmuts and the latter town was introduced while the conversion was in progress, and a third rail was also put in from Durban Road to Cape Town. Thanks to this it was possible to use both broad and narrow gauge rolling-stock. The former went from Cape Town to Klapmuts via Stellenbosch and the latter via Kraaifontein. As might be expected, this proved a very cumbersome arrangement, and the Governor, Sir Bartle Frere, was moved to appoint a commission to suggest improvements

" It would be a great advantage ", the latter body reported, " in the working of the Western System generally, if the broad gauge rails on the line between Salt River and Durban Road were removed and the narrow were substituted for the broad gauge between Durban Road and Muldersvlei via Stellenbosch "

Not until 1880 did the 4 foot 8½ inch gauge disappear on the Stellenbosch route, and at the same time the third rail, allowing the use of 3 foot 6 inch rolling-stock, was laid between Cape Town and Wynberg. The end of this dualism only came in 1881, twenty-one years after the first trains had run in South Africa.

Much criticism has been voiced at different times about the handicap of the 3 foot 6 inch gauge, particularly in the matter of speed, but South Africa has not found the gauge to be a limiting factor of any consequence. The width of rolling-stock is as great as that in use on British and European railroads ; riding is comfortable despite the overhang ; and the 3 foot 6 inch gauge has proved adequate in coping with grades and curvature, while construction costs are not nearly as heavy as they would have been had the broader gauge been maintained. Confronted as they were with mountain barriers, not only between the Cape Western Province and the Karroo, but between the east and the west of the Colony the engineers were yet able to carry out works of a boldness which is frequently neither appreciated nor recognised by the public.

More than sixty years ago, in 1886, Mr. John Noble, Clerk of the House of Assembly, was able to report :—

> These railways have been carried out on the 3 foot 6 inch gauge, and with the exception of the Cape Town and Wynberg line, and the first seven miles of the Port Elizabeth and Uitenhage line, are all single lines.
>
> Some portions of the lines are, in an engineering point of view, highly creditable to the engineers who laid them out and superintended their construction. The entry into the Karroo over the Hex River range of mountains is specially worthy of notice. From the town of Worcester (780 feet above sea level) the line proceeds up the beautiful Hex River Valley, and then begins to climb the mountains by curves and zigzags along their sides, piercing some of the mountain spurs by tunnels, and crossing gullies spanned by viaducts, until within a distance of 36 miles it attains an altitude of 3,193 feet. Looking down from the top of the mountain there is a magnificent view of the valley, some 2,000 feet below ; and the stupendous character of the engineering work by which the ascent has been accomplished can be fully appreciated. For upwards of twenty miles the line is steep in gradient (1 in 40 and 1 in 45), sharp in curve, deep in rock cutting, and precipitous in embankment. The highest point, however, is at Pieter Meintjes Fontein, 77 miles from Worcester, where a height of 3,588 feet is attained—a little higher than the summit of Table Mountain. Beyond this high level it again descends, being 2,717 feet at Buffels' River, and 1,537 feet (the lowest point beyond Worcester) at the Dwyka River ; then ascending again, the altitude of 2,379 feet is attained between Prince Albert and Fraserburg Road, and it finally runs into Beaufort West at an altitude of 2,778 feet. From thence to Kimberley the Western line is on comparatively easy ground. The highest point (5,185 feet) on the Midland system is at Bosworth, near Naauwpoort, 164 miles from Port Elizabeth, from whence the country is generally flat to De Aar, the junction with the Western system, at 339 miles from Port Elizabeth and 500 miles from Cape Town. The Eastern system attains its summit (5,586 feet) on the top of the Stormberg range, 207 miles from the coast at East London.

The example set by South Africa has been followed by most other territories in the Black Continent. The main exception is the line in Egypt running south as far as Luxor, which is of 4 foot 8½ inch gauge. The railway systems of the Sudan, Belgian Congo and the Rhodesias are to the 3 foot 6 inch gauge, but a most unfortunate exception has arisen in East Africa

where, through a misunderstanding as far back as 1892, the metre gauge was adopted. The immediate reason was that in the Anglo-Egyptian Sudan the Railway Committee at the Foreign Office had originally chosen this as a standard. Lord Cromer, the great British Administrator, who preferred the 3 foot 6 inch gauge, failed to notify the Committee of the alteration. Work was begun on the line to the interior from Mombasa using the metre gauge, and by the time the discrepancy was realised two-thirds of the line to Uganda had already been completed.

Within the Union itself there are certain comparatively minor sections on which a narrower gauge than 3 foot 6 inch has been adopted, but it has now been decided not to construct further sections of narrow-gauge railway, and in time to come the present lines will disappear. Narrow gauge in South Africa generally means 2 ft., and this was originally adopted for reasons of economy since in difficult mountain sections construction could be carried out at greatly reduced costs as compared with the standard 3 foot 6 inch gauge. The first stretch of narrow-gauge to be built was opened in 1876, namely the 100-mile dead-end line from Port Nolloth to the workings of the Cape Copper Company in Namaqualand. (It was of 2 foot 6 inch gauge, and was uplifted in 1944.) Twenty-seven years later, on February 28, 1903, the first section of 2 ft. gauge was opened—from Kalabas Kraal to Hopefield—and soon after on July 18, 1907, another branch was put into use in Natal, for 28 miles between Weenen and Estcourt. To-day the Union and South-West Africa between them have 793 miles of 2 ft. gauge line.

The manner in which population in South Africa is concentrated in districts lying between vast stretches of almost empty country is not only one of its most striking geographical features, but a major factor in determining the method of locating the railways. After days of travelling across the veld, first by ox-wagon and later by coach, the pioneer colonists reached the Diamond Fields. After more days they found their way to the gold country of the Transvaal.

The apparent endlessness of the Karroo and of the Highveld has changed comparatively little with the passing of the decades, nor has the suddenness with which modern cities and all the paraphernalia of industrialism leap out of a virgin land. Hence the intensity of the traffic which flows over the rails from these major centres of population bears no relation to the rawness of the landscape. According to the latest census nearly 50 per cent. of the white population of the Union lives in and near Johannesburg. This may be no greater than the concentrations of inhabitants at Sydney, Melbourne, Adelaide, Brisbane, and other centres of Metropolitan Australia, but whereas the latter are all at the coast, the heart of South Africa is more or less in its centre. Hence the railways have formed a spider's web across the map—leaving out only the semi-desert north-western reaches of the Union which are hemmed in by the Kalahari.

Because they were the substitute for rivers, the Railways were always faced with demands for the transport of agricultural produce, and it has been a problem how to reconcile economic working with these claims. Hence, too, the urge to unite all systems under a common control, those of the two colonies as well as of the two republics, long preceded the founding of the Union of South Africa. Even during the South African War in December, 1901, Lord Milner, then High Commissioner, wrote :—

> It seems almost superfluous to argue the case for further railway development in South Africa, and especially in the new Colonies. The richest agricultural districts of both Colonies are far removed from markets. The through lines from the coast to the great centres of industry will be choked with traffic. Both to stimulate agriculture and to facilitate the operations of commerce, additional lines and relief lines will be urgently required. Moreover, if the construction of the most necessary of these is undertaken as fast as the districts through which they pass are pacified, employment will be provided for large numbers of persons, who would

Dining Car

otherwise be idle and dependent on Government for relief, as well as for many new-comers, who will be a valuable addition to the population of the country. And there is no work which will have a more excellent effect in promoting the pacification of the country. If there is one enterprise which is certain to be thoroughly popular with the old population, it is this.

Local rivalries were the main obstacle on the path towards real progress, and these could only be overcome by effective unification. Discrimination in rates and attempts to catch traffic from the profitable Transvaal goldfields by undercutting played havoc with the budgets of the coastal colonies. There was squabbling and there were recriminations. Milner saw the fundamental difficulty when he wrote on May 31, 1904, at the time when the keynote of policy was the restoration of damage done by the South African War :—

We begin to see the end of the funds available for railway construction out of the Guaranteed Loan. These funds may suffice, after the completion of the lines already in progress, to complete the connection between Harrismith and Viljoen's Drift, and to connect the Rand with the rich agricultural districts of the Western Transvaal. But even if this is done, there will still be a great extent of country almost totally devoid of means of communication. It is said that we are in danger of throwing away money on lines which will never pay, and that we shall be benefiting the country at the expense of the towns, which already have to bear the chief burden of taxation. Why should industry and commerce make these sacrifices on behalf of agriculture, or the great urban centres come to the support of remote agricultural districts? Well, why should the heart, with great effort, pump blood to the extremities? We are one body politic. But apart from such, it is good business, in the long run, to increase agricultural resources as well as to extend the area of industrial development. Of course, no one in his senses would advocate any and every suggested branch line. But a steady and gradual improvement of the means of communication is, it seems to me, as essential to the welfare of the towns as to the country itself. There are branch lines which may not pay directly, but will pay indirectly, not only by increasing the profitable traffic of the main lines, but by bringing business to the towns—the farmer who is enabled to sell produce, which he now cannot sell, will then be a customer for goods which he now cannot buy.

The delegates of the Cape of Good Hope, Transvaal, Natal and Orange Free State, who met in 1908 to begin the discussions which terminated in the establishment of the Union of South Africa, were in fundamental agreement about the principles to be observed by the proposed unified Administration. The resolution agreed to and embodied in the new Constitution was : " The Railways, Ports and Harbours of the Union shall be administered on business principles, due regard being had to agricultural and industrial development within the Union and the promotion, by means of cheap transport, of the settlement of an agricultural and industrial population in the inland portions of the Union ".

Chapter III

EVOLUTION OF STATE OWNERSHIP.

THIS, then, was the background of railway development in South Africa. The evolution of State ownership and control was a natural process of which the seeds were planted when railway construction was first projected. In South Africa the balance of opinion seems to have been in favour of State ownership from an early date, for while the first company in the Cape was originally conceived as a private concern, and operated on the authority of the Government together with a measure of financial guarantee, private ownership lasted only until January 1, 1873. Then, after a favourable report, possession was handed over to the Honourable Charles Abercrombie Smith, Commissioner of Public Works.

The Cape Colonial Government received authority " to raise money for the purchase in the form of debentures, not exceeding £500 and of not less than £100 each, bearing interest at 4½ per cent., the total issue not to exceed £780,000, and the interest to form a charge upon the revenue of the Colony ". As, however, this left the lease of the line from Cape Town to Plumstead untouched, an outright purchase for a further sum of £75,000 was approved.

In the same year Natal at last decided to buy out the small existing system running from the Point to Durban and on to Umgeni. Here the consideration was £40,000, and State ownership came into effect on July 1, 1876.

Strictly speaking this did not mark the entire ending of private enterprise in South Africa. Not only did the railway in Namaqualand continue to function, but other minor lines were built between Grahamstown and Port Alfred, as well as on the Cape Central route from Worcester to Mossel Bay, through the forests at Knysna, and to the Cape Town suburb of Milnerton. In Natal the development of the coal mines and sugar plantations caused the laying down of some private railways, while the Transvaal, in addition to the famous Netherlands Company under the Republican regime, had some lesser concerns as well. These have all now disappeared.

Starting as an off-shoot of the Department of Crown Lands and Public Works in 1873, the Cape Railways for a while continued to be operated under the jurisdiction of this department. The senior official was still W. G. Brounger, who was taken over from the Cape Town Railway and Dock Company and who held the simple title of " Railway Engineer " (Salary £1,200 a year). The whole section was called " The Department of the Railway Engineer for the Colony ".

In 1880 the name was changed to that of the Cape Government Railways. Mr. Brounger having retired, Mr. C. B. Elliott, afterwards Sir Charles Elliott, was appointed the first General Manager and this able official, having been granted the necessary additional powers, greatly improved the general efficiency of his Administration. In its broad outlines the system of operation bore a considerable resemblance to that which still prevails. At the head was the General Manager's Department, assisted by the Accounting Department, Locomotive Department, Maintenance Department, Traffic Department, Stores Department and Wharf Department (in charge of Harbours).

As a result of the construction of isolated sections of railway line at different points along the coast, namely Cape Town, Port Elizabeth and East London, there was a Western System,

a Midland System and an Eastern System, using the identical designations as are found to-day. (Before that there had been the Western System, the Central System and the Border System, with headquarters at Cape Town, Port Elizabeth and East London respectively). From the start a separate organisation was maintained for " Construction Service, Traffic Maintenance and Engineering and Locomotives, as well as for Terminal Works "

One of the most remarkable features of the upbuilding of the Cape Government Railways, in the light of later events, is that the man responsible was of South African birth. Whereas W. G. Brounger was trained in the classical Stephenson tradition, Elliott had never " gone through the mill ". He was born at Uitenhage on May 8, 1841, and his education, though partially received in London, did not even envisage a railway career. Starting as a clerk to Mr. Justice Cloete he had entered the Civil Service, been Resident Magistrate at Wynberg and Cape Town, and only because he had been transferred to the post of Chief Clerk to the Minister of Crown Lands and Public Works was he brought into touch with railways at all. Merely because he had been made Assistant Commissioner of Crown Lands and Public Works in 1876, was he offered the position of General Manager of Railways. None the less Charles Bletterman Elliott made a great success of his task, which he continued for nearly a quarter of a century. He was the first of a new race of South African born railwaymen.

Sir David Hunter, who became General Manager of the Natal Government Railways in 1879, was, on the other hand, steeped in overseas practice. He was born in the same year as Elliott, namely 1841, at Broxburn in Linlithgowshire, Scotland, and had served his time with the North British Railway Company from 1853 onwards, until he came to South Africa. He left the impress of a strong personality on the methods of his Administration and on those of the neighbouring territories, not excluding the Cape. From the start the Natal Government Railways were self-contained. Hunter caused the Natal Railways to be administered locally under District Superintendents. He also acquired an Assistant Manager, a Traffic Superintendent and a Superintendent of Labour and Police. Although it was not the capital of the country, the head office was at Durban, while the District Superintendents were at Pietermaritzburg and Ladysmith.

Foreign precedent, with its roots in the Netherlands, was strong in the Transvaal under President Kruger, but in the Orange Free State, also an independent republic and one not subject to the theoretical " British suzereignty " applicable to the Transvaal, the system was almost completely assimilated to the British one. This arose from the fact that under the Railway Convention of June 11, 1889, the Cape built the line from Norvals Pont on the southern border, to Bloemfontein, at a cost of £604,627, provided rolling-stock to the value of about £60,000, and operated it on behalf of the Orange Free State. Later on the same methods were applied to carry the system to the Vaal River, on the borders of the South African Republic, which was reached on May 8, 1892.

The Cape Government Railways continued to run the Orange Free State Railways till the end of 1895, whereupon the effects of the Jameson Raid showed themselves. Alarmed at what it regarded as a possible threat to its own independence, the Orange Free State gave notice, as it was entitled to do under its agreement, that it proposed to take over the control of all lines within its own borders. In practice, however, it was necessary to continue the methods already in use.

Because the Netherlands South African Railway Company was controlled by Netherlands and German interests, the citizens of those countries acquired an overwhelming say in the lay-out and operating methods. Fortunately no gauge other than that of the Cape was ever contemplated, but almost the entire staff was non-British. Engineers were

mainly Hollanders, rolling-stock was purchased from Germany. The General Manager was Mr. G. A. Middelburg, previously Chief Mechanical Engineer of the " Hollandsche Ijzeren Spoorweg Maatschappij in succession to Mr. J. L. Cluysenaer. The ability of many of his senior officials such as Verwey, Kretschmar van Veen, and others, was undoubted.

Government control was maintained to a limited extent by means of a special Railway Commission, originally appointed in 1887, which reported to the Volksraad and which employed its own staff and Technical Inspector, under the chairmanship of Mr. J. S. Smit. The seat of the Nederlandsche Zuid-Afrikaansche Spoorweg-Maatschappij Administration was at Pretoria, although the head office of the Company was in Amsterdam.

The System was divided up into the Eastern Line, running from Pretoria to the Portuguese Border, and including a branch from Kaapmuiden to Barberton ; the " Rand Tram ", originally operating only from Boksburg to Johannesburg, subsequently extended to Springs ; the Southern Line from the Vaal River to Germiston, and Johannesburg ; the South-Eastern Line from Pretoria to Elandsfontein (Germiston) and to the Natal Border ; the South Western Line from Klerksdorp through Potchefstroom to Krugersdorp, and the various branch lines.

Additional to these were the independent concerns, which built the Selati Railway (founded in Belgium), as well as the Pretoria–Pietersburg Line. The Selati line, which traverses that part of the Transvaal now known as the Kruger National Park, one of the most famous wild animal sanctuaries in the world, was built in 1891–92, but was abandoned. For eighteen years the rails lay rusting in the fierce sun of the sub-tropics, and it was not until 1910 that the line was brought into operation.

The Pretoria–Pietersburg Company was noteworthy because it allowed for the subscription of £300,000 in capital by the Government and represented the financial entry of the Republic into the field of railway building. On the Board there were several State representatives.

With the outbreak of the Boer War and the disappearance of the Netherlands Railway Company, the Imperial Military Railways, followed by the South African Railways, dominated the picture. The Netherlands Railway Company came to an end at the conclusion of the Second South African War, but its influence, expressed in fine stations and excellent engineering methods, is still discernible.

The way was now clear for the eventual constitution of the South African Railways, but the Union of South Africa was not yet dreamed of, and many years elapsed before the unification of the different railway systems was consummated.

In pre-Union days the Cape Colony and Natal fought for the remunerative traffic to the Rand, while the Orange Free State, as part of the Central South African Railways, tried to divert traffic to the lines crossing its territory, irrespective of economic considerations. Lourenco Marques had preferential rights under the Mocambique Convention and the Transvaal preferred to use that route which was by far the cheapest. Lord Selborne, High Commissioner for South Africa and successor to Lord Milner, issued a famous memorandum on unification in 1907. " This divergence, " he said, " this conflict of railway interest, would vanish like a foul mist before the sun of South African federation, but no other force can dissipate it. There would no longer be a conflict of interests between the railway systems of Natal, of the Cape Colony, and of the Orange River Colony. Nor would it any longer be to the interest of the Transvaal to lead exclusively to Delagoa Bay. The wealth of the Transvaal would be used, not in enriching a foreign port and a foreign country, but in building up a great white population in the British ports of British South Africa with interests identical with her own. "

The case for State ownership was set out with great clearness in *The Government of South*

Over coastal mountain ranges to interior. The railway track through the Montagu Pass.

Africa, a compilation prepared by the " Closer Union " Organisation in 1908 :—

A railroad, like an ordinary road, requires a continuous way-leave over land, whether public or private, and must therefore be constructed with the authority of the State. But though government alone can enable a line to be built, it does not follow that it must build the line itself. Indeed, where its interests, military or otherwise, in transportation are comparatively small, its natural inclination is to leave the responsibility for organising the intricate details of a railway system and for the great expenditure involved, to private corporations. We have pointed out that if the system of transport is to be organised as cheaply as possible, it must be placed in the hands of one management, except where the system is unusually large. But one private corporation vested with such powers would be more powerful than government itself. The State, therefore, has two alternatives. Either it may divide the traffic among different companies in order that competition may restrict their charges to a reasonable level, or it may face the responsibility of owning and working the system as one great public concern. Which of the two alternatives is chosen the circumstances of each case will determine. In countries like England and the United States, where the direct interest of the government in transportation is relatively small and where there is plenty of room for competition, railway transport is left in the hands of companies. In countries like Germany, where for military reasons government is supremely interested in railway transportation, the State is driven to own and work the railways for itself. In new countries like South Africa, railways are necessary to develop vast and thinly-peopled areas even before they would pay for the purposes of commerce. Private enterprise naturally hesitates to come forward, and in the few instances where it might be inclined to do so, it would be deterred by the prospect of competition, because the volume of traffic available is too small to be shared between two lines. Private lines could only be constructed on a monopolist basis. But in a vast country, entirely devoid of waterways, it would be intolerable to have one private corporation controlling the entire system of communications. In these circumstances the government has itself undertaken the responsibility of building and administering the railways in South Africa. Whatever its demerits are, this course has the advantage that it prevents the holders of a private monopoly from exacting extortionate charges from the public and becoming too powerful a subject of the State. It also enables the whole of the traffic within the jurisdiction of the government to be handled by one system, and this, as we have shown, should help to cheapen transport.

Where, however, one country is arbitrarily divided into a number of territories with different governments, it is apparent that some of the benefits of State management are lost. Divided ownership does not allow the maximum traffic to be dealt with by a single corporation, nor the cost of working to be brought to a minimum. Moreover, if the people of one territory depend on the railway of another, the government of the latter will be tempted, like a private company, to make unreasonable charges, so far as it is not restrained by competition or diplomacy. Under such conditions all the disadvantages inherent in the public management of commercial undertakings like the railways are combined with many of those which result from private ownership.

The map of South Africa shows that its railways are in this unhappy position. The great competitive zone for the occupation of which the coast railways are fighting is the mining area of the Rand. The main railway systems connecting the British ports with the interior are owned and controlled by the governments of the four principal colonies. In the Cape Colony their administration rests with the Commissioner of Public Works, and in Natal with the Minister for Railways and Harbours. The railways of the Transvaal and the Orange River Colony were placed after the war under the control of the Inter-Colonial Council. This body, which met once a year, delegated the management of its railways to a committee consisting of a chairman, the treasurer of the council, and seven other members. The Inter-Colonial Council and its railway committee have just expired, but the railways of the two colonies are to remain united, under a joint board of five members, three appointed by the Transvaal and two by the Orange River Colony.

With the general realisation that Union must come and that soon, information was obtained from all parts of the world to guide the authorities in framing the new plans. Australian experience was particularly useful because here too there were several separate State-controlled administrations. Powers granted by the Commonwealth to the Railway Commissioners helped to stimulate the idea of founding a supervisory Railway Board.

" The final power and authority and voting of estimates, " said *The Government of South Africa*, " rests with Parliament, as it must in all cases, where Parliament is the supreme legislative authority. "

" The executive Government retains a certain power of supervision, especially over the issue of bye-laws and the imposition of rates and fares. "

" But the ordinary working and management of the railways is left wholly to the Commissioners. "

" The general opinion in Australia seems to be that the system of non-political control of its railways has proved a success. It has been possible to administer the railways in a more business-like manner. The fact that Commissioners are appointed for a term of years has secured a greater continuity in management than could have been possible under the old conditions, and the discipline of the employees has been considerably improved thereby. This can easily be understood when it is remembered that in the colony of Western Australia there were within the space of four years, from 1901 to 1905, no less than nine ministers of railways. "

The National Convention at Vereeniging in 1908 brought to light many divergent ideas on the question of operating railways. A committee representative of all the colonies was charged with framing the basic principles of administration. The whole country was clamouring for railway lines. It was manifestly impossible to satisfy everybody since in many sparsely populated areas the prospect of operating profitable services was exceedingly remote. Something obviously had to be done to develop districts of this type, and out of this necessity was evolved the following formula incorporated in the Act under which the South African Railways were established :—

So far as may be, the total earnings shall not be more than sufficient to meet the necessary outlays for working, maintenance, betterment, depreciation and the payment of interest due on capital invested therein, not being capital contributed out of Railway and Harbour Revenue, and not being interest on any capital which Parliament may provide. The amount of interest due on such capital invested shall be paid over from the Railway and Harbours Fund into the Consolidated Revenue Fund.

This was the preliminary form in which the principle of stability in revenue was enforced.

Careful attention was given the comparative statements of traffic, staff, and revenue prepared for the information of delegates and based on the figures for the year 1907. In view of the vast development which has followed unification and the establishment of the South African Railways, these returns, which are still available, will repay examination.

The Union of South Africa came into existence on the anniversary of the day when peace was signed at Vereeniging between the delegates of the Republics, the Transvaal and Orange Free State on the one side, and the British Empire on the other. The adjustment and welding together of the three separate railway administrations—the Cape Government Railways, the Natal Government Railways and the Central South African Railways into one whole, was a task that could not be carried out overnight. The officials, however, were there with the goodwill and the ability to do so, and under the first General Manager of the South African Railways and Harbours, the late Sir William Hoy, they set to work, and the system has grown steadily with the years to its present scope and importance, as described in the ensuing chapters.

Chapter IV

MANAGERIAL CONTROL

MANAGEMENT AND CONTROL.

While the system of managerial control of the South African Railways is substantially the same as that set up at Union in 1910, there have been certain important changes in the general management structure, brought about by the ever-widening scope of railway interests and the growth of the Service. It became increasingly clear with the years that the General Manager had become overloaded with routine executive work, and in 1945 the whole position was reviewed in the light of the increasing complexity of administration, the growing volume of work, the diversity of problems and the heavy responsibility that devolved on the General Manager. In the interests of efficiency, a new system of managerial control and a new conception of managerial responsibility was devised in order to meet the exacting demands of present-day conditions. Responsibility and control were decentralized to some degree, while the position of the General Manager in relation to the Minister, the Railway Board and his own Departmental Heads was more clearly defined.

Seven Chief Managers were appointed—Technical ; Harbours, Shipping and Development ; Commercial and Industrial ; Operating ; Financial ; Staff ; and Airways—each with definite functions, and directly responsible for the managerial matters falling under his jurisdiction to the General Manager, whose position as executive head of the South African Railways was strengthened by the changes. The General Manager, relieved of a considerable amount of detail work, is now able to devote more time to questions of general policy. He is assisted by a Deputy General Manager. The latter and the seven Chief Managers function virtually as a Committee of Management under the General Manager.

One of the cases where the original intentions of the Fathers of the South African Constitution have been varied by reason of experience, is in the operation of the Railway Board. Under the Act of Union, as adopted in 1910—" subject to the authority of the Governor-General-in-Council, the Control and Management of the Railways, Ports and Harbours of the Union shall be exercised through a Board consisting of not more than three Commissioners, who shall be appointed by the Governor-General-in-Council, and a Minister of State who shall be Chairman ". The Act laid down that Commissioners were to hold office for five years, but could be reappointed. They were only to be removed by special action of the Governor-General and Parliament, while their salaries, like those of judges, were irreducible.

In actual practice the interpretation of the words " authority . . . exercised *through* a Board " gave rise to friction and misunderstanding, so much so that in 1916 it was decided to clarify the position, since, with the Minister a member of the Cabinet and also Chairman of the Railway Board, there was always a possibility—remote it is true—of an Executive Council decision being resisted by the Board. Such a situation would be embarrassing to the Minister concerned, and could lead to constitutional anomalies. The then General Manager of Railways, Sir William Hoy, had also found his effective authority circumscribed by the existence of the all-powerful Railway

Board and the Railway Board Act of 1916 defined its powers afresh.

In this amending legislation it was laid down :—

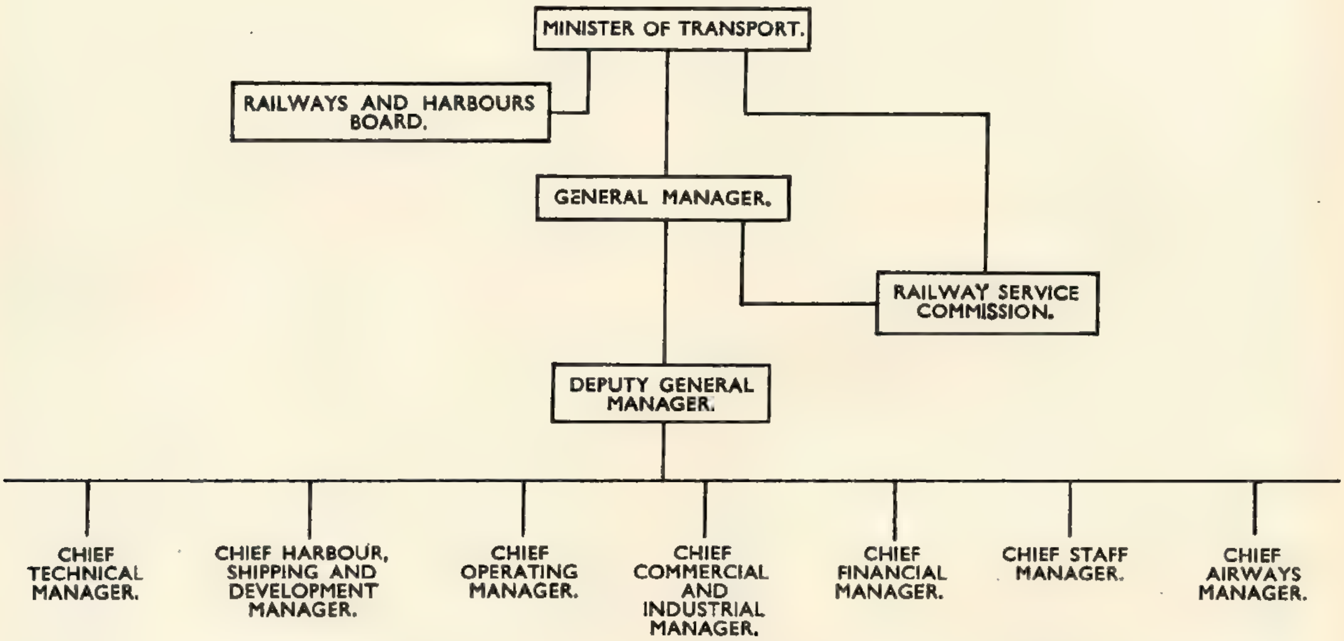
The Railways, Ports and Harbours of the Union shall be administered and worked under the control and authority of the Governor-General-in-Council, to be exercised through a Minister of State, who shall be *advised* by the Board. The Management and working of the Railways and Harbours shall, subject to the control of the Minister be carried out by the General Manager, who shall be governed by such regulations as the Minister may from time to time frame *after consultation with the Board.*

Since that time the Railway Board, functioning in an advisory capacity, has made valuable contributions by advising the Minister on questions of policy and on matters related to the general operation and control of the Railways. While these changes appeared to detract from the authority of the Railway Board, they did provide constitutionally a more workable and more logical form of administration.

Statutory provision is made for the Railway Board to function as the final court of appeal in connection with disciplinary punishments and promotion appeals.

The following graph shows the main features of the administrative and managerial organisation :—

ORGANISATION.



STAFF DEPARTMENT.

The staffing of the first railway companies to be formed in South Africa presented unusual difficulties. The country was young ; development was in its early stages and was confined to a few centres, separated by formidable mountain barriers and big distances ; and labour resources were so limited as to be practically non-existent.

Engineers from Britain, the Netherlands and other European countries, as well as a considerable number recruited from British Regiments in India and the Far East, did the survey and construction work, but when it came to operating the difficulties were even greater. Large scale recruitment had to be carried out in Europe, and South Africa's first railways were, therefore, worked exclusively by imported drivers, station masters, clerks, artisans and technical staff.

The European South African, however, showed a great aptitude for and interest in railway work, and the infiltration of South Africans into the railway service started almost at once, but the influences of the pioneer days are still discernible. Control and operational methods resemble—though to an ever-decreasing degree—those applied in Great Britain and the Netherlands, and the evolution of a distinctly South African character in the management, control and operation is steady but sure.

All these factors have influenced railway staff policy, which has had to be adjusted from time to time to meet changing conditions. The first phase—recruitment of labour overseas—was followed by the development of a predominantly non-European labour force to do manual labouring duties, and the gradual introduction of South Africans to railway work. Then came the period of intensive development after Union, when South Africans emerged in ever-greater numbers as engineers, drivers, artisans, clerks, station masters, and other highly-trained operatives. At present the staff of the Railways is almost exclusively South African; technical men are trained in the country, and the Railways have established a Central Training Institute to meet their own requirements.

At the end of 1946, the staff of the South African Railways totalled nearly 175,000, of whom 93,000 were European, 10,000 Coloured, 600 Indians and 71,000 Bantus. About one-fifth of the European staff are employed on manual labouring duties while the great majority of the Coloured, Indian and Bantu servants (known as non-Europeans) are similarly engaged.

To assist the management in the selection and promotion of staff, a permanent body—the South African Railways and Harbours Service Commission—was established in 1935. This Commission, whose functions bear a distinct resemblance to those of the Public Service Commission of the Union, has advisory powers only, and makes recommendations to the Minister, General Manager or to departmental heads, as and when required to do so. The Commission is composed of a Chairman and two members, and officers or retired officers of the Railway Service are eligible for appointment.

The employment policy of the Administration in the filling of vacancies is governed by the class of work desired by the candidate. The method of recruitment in so far as the principal categories of European staff are concerned are :—

Professional Appointments.

The appointment of youths to the professional group, which includes civil, mechanical, electrical, signal and motor engineering, is contingent upon candidates being in possession of, at least, a university degree of Bachelor of Science (Engineering). Applicants with the necessary qualifications are engaged initially as pupil engineers and are required to undergo practical training for a period of from three to four years, the period of training being determined by the nature of the work.

Clerical Appointments.

The selection of youths for appointment to clerical positions is made by means of an annual competitive examination. The examination is designed as a general test of the candidate's knowledge, intelligence and initiative and the subjects include English, Afrikaans, general knowledge and accuracy.

Successful candidates at the competitive examination are, in order of merit, considered for appointment as probationer clerks, one-half of the available vacancies being offered to servants of the Administration who were successful at the examination, the remaining vacancies being filled by the successful candidates who are not in the Service.

Apprenticeship.

The selection of youths for apprenticeship to artisan trades is also made by means of an annual competitive examination. Fifty per cent. of the available vacancies for apprentices are

reserved for candidates already in the employment of the Department, the remainder of the vacant positions being offered to the successful candidates who are not in the Service. Successful candidates are placed in an order of merit determined by the results at the examination and are offered the choice of trades in which there are vacancies.

The apprenticeship covers a period of five years and on its satisfactory completion the apprentice is granted full artisan status.

All Other Male Grades.

Prior to October, 1944, vacancies in the majority of grades were filled by promoting men who had entered the Service as railworkers (manual labourers). It was found, however, that by insisting on men joining the Service as railworkers the Railways were not attracting the best type of recruit. There was a general and understandable reluctance on the part of applicants for work to start as railworkers. These disadvantages were obvious—manual work had to be done ; there was no specific prospect of early promotion ; and no rational programme of training.

It was accordingly decided to create the grade of " trainee ", on a scale of remuneration higher than that applicable to railworkers. Applicants with the requisite qualifications are now appointed as " trainees " and after progressing to learner grades they form a reservoir from which vacancies for graded adult appointments are filled. Railworkers in the Service may also be selected as " trainees ".

Female Grades.

Women who are recruited to fill vacancies in the grade of typist, woman clerk, travel hostess and telephonist are required to be in possession of at least the junior certificate, with English and Afrikaans as qualifying subjects.

Women are also recruited and trained to undertake social welfare work among the families of the railway staff, and when fully qualified are graded as women welfare officers. The training period is reduced in the case of candidates who are in possession of a Bachelor of Arts degree with Social Science as a subject, or have qualified in general nursing and midwifery.

Women are also recruited to fill vacancies in the grade of waitress, laundry assistant, bookstall attendant, messenger and a number of other positions for which they are considered suitable.

Manual Labouring Staff.

Adult European males who are recruited for purely labouring duties in track-maintenance gangs, goods shed gangs, workshops, running sheds and on stations, are afforded an opportunity of progressing to a number of specified graded positions in the Service. Whilst the majority of non-Europeans (Coloured, Indian and Native) are recruited for labouring duties, some of the staff in this group advance to such positions as driver of animal-drawn vehicles, bedding boy on trains, and supervisor of non-European labouring gangs.

Training of Staff.

During 1938 a departmental committee was appointed to enquire specially into matters affecting the training of staff. This led to the establishment of the Central Training Institute at Esselen Park, which is situated between Johannesburg and Pretoria. The war delayed the building programme but the training of staff, particularly the large number of ex-volunteers taken into the Service, was undertaken at Kroonstad, where buildings previously used as an air training school were available.

Intensive training, on practical and theoretical lines, is afforded in various railway subjects, among which are included goods and coaching accounts, trains-working and telegraphy, engine drivers', guards', shunters' and checkers' duties. Provision is also made for the training of railway police and catering staff and facilities are available for physical education and sport.

The Central Training Institute is under the supervision of a trained educationalist as

principal, while the management and control of the establishment are vested in a committee consisting of a number of senior officers, representative of the various branches of the Service, who are stationed at Headquarters, Johannesburg. This committee, which functions under the chairmanship of the Chief Commercial and Industrial Manager, is responsible to a Board of Governors consisting of the three Railway Commissioners and the General Manager. The Board of Governors is responsible to the Minister of Transport.

Development ot the Consultative Machinery.

The present method of negotiation between the staff and the Administration regarding conditions of service is based fundamentally upon recognition of various staff associations as the sole negotiating bodies on matters affecting the groups of staff they represent.

These staff associations have been registered under specific provisions in the Industrial Conciliation Act, 1937 (Act No. 36 of 1937), which enables them to secure registration as trade unions. The general provisions of that Act are not applicable to the Railways which, as a Department of State, regulates the service conditions of its staff by legislation and domestic negotiation. Registration under the Industrial Conciliation Act, 1937, however, confers the corporate status of a trade union upon the railway staff associations. Questions relating to the associations' functions vis-a-vis the Railway Administration, are settled by mutual arrangement between the Administration and the associations concerned.

There are at present six European railway staff associations recognised as negotiating bodies by the Railway Administration, and each of the associations caters for a group of staff with a broad identity of service interests and affinity of working conditions.

The staff associations, representing the six groups of staff, are :—

Group.	*Grades of Staff.*
Group " A ".—	Salaried staff, i.e. clerical staff, station masters, inspectors and other salaried officers.
Group " B ".—	Footplate grades, i.e. drivers, passed firemen, firemen and probationer firemen, shed staff and staff operating mechanically propelled vehicles (motor bus or lorry drivers) (road motor services), motor vehicle drivers, etc.
Group " C ".—	Operating grades, i.e. station foremen, signalmen, shunters, guards, ticket examiners, etc.
Group " D ".—	Artisan and semi-skilled occupations.
Group " E ".—	Miscellaneous grades, i.e. checkers, cranedrivers, platelayers, gangers, catering stewards, storemen, police constables, police sergeants, marine staff, etc.
Group " F ".—	Staff graded as railworkers who normally undertake manual labour.

There is also a Consultative Committee comprising three members and a secretary from each of the six European railway staff associations. The Consultative Committee meets periodically and its functions are—

(i) to enable staff associations to exchange and co-ordinate their respective views concerning matters affecting more than one group of servants ; and

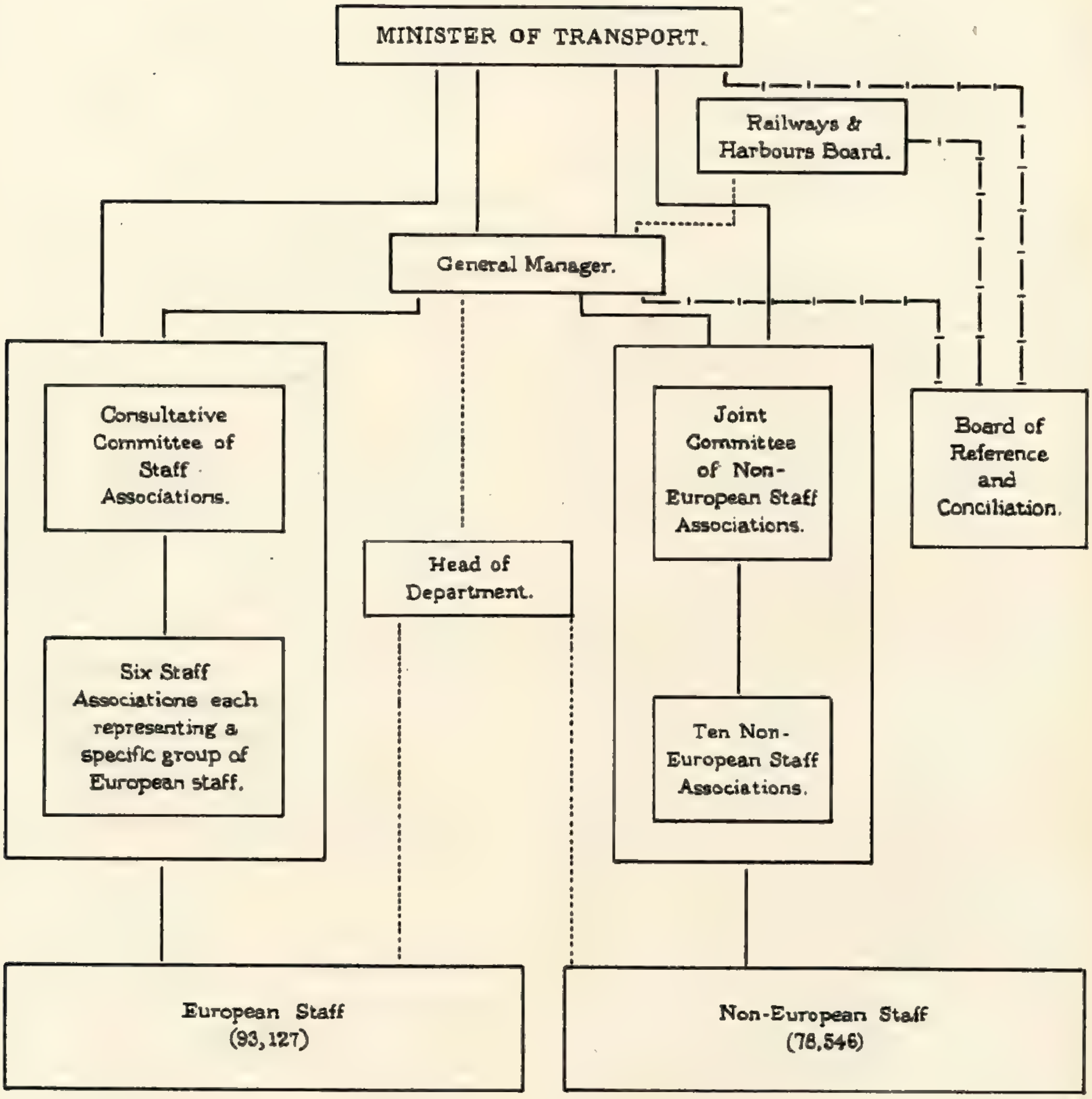
(ii) to enable the Administration to obtain through one channel the views of the various staff associations upon matters affecting more than one group of staff.

The Administration meets the Committee in conference at least once a year for the purpose of facilitating an exchange of views upon matters of common interest.

In accordance with the provisions of section *twenty-four* of the Railways and Harbours Service Act, 1925 (Act No. 23 of 1925), a permanent board of reference known as the Conciliation Board is comprised of six members nominated by the Minister of Transport, one of whom is nominated as chairman, together

DEVELOPMENT OF CONSULTATIVE MACHINERY

CONSULTATION & APPEALS



Normal consultative machinery through Staff Associations.

Appeals machinery, (Promotions and disciplinary punishments).

Conciliation machinery, which deals only with items specifically referred to it by the Minister. the Railways and Harbours Board or the Management.

with six representatives of the staff, one of whom is chosen by such representatives to be vice-chairman.

The representatives of the staff on the Conciliation Board consist of one representative from each of the groups. The Conciliation Board deals with any matters referred to it by the Minister of Transport, and its main functions are to consider and report on important matters involving conditions of service, rates of pay, or principles underlying disciplinary decisions, in connection with which differences may exist between the Administration or the Management on the one hand and large bodies of the staff on the other.

Matters may be referred to the Conciliation Board at the instance of a staff association ; or by the direction of the Administration or Management ; or on the initiative of the staff, providing that a petition is signed by not less than one-fifth of the members of any grades affected.

Non-Europeans.

Non-European members of the staff have organised staff associations within specified areas throughout the Union and South-West Africa. Membership is open to all grades and groups of non-European servants, and there is a joint committee, with headquarters at Johannesburg, to co-ordinate the activities of the various associations.

It is a significant fact that notwithstanding the many instances of industrial unrest in other industries, the railways have been relatively free from such disturbances. This can be largely attributed to the conciliation machinery provided for negotiation between the staff and the Administration.

SOCIAL SECURITY.

Social security for the staff of the Railways and associated services is implicit in Railway policy. Employees are encouraged to own and build their own homes—many enjoy assistance in the matter of rent ; the Railway pension fund covers every European on the permanent and temporary establishment ; a medical benefit scheme ensures medical attention and hospitalisation, and many other measures are applied to assist the staff in different directions.

Before describing the various social measures in detail, it is important to explain that the staff of the Railways are divided into three categories—permanent, temporary, and casual. To qualify for permanent employment a servant must—under the Railways and Harbours Service Act (No. 23 of 1925)—have two or more years of continuous employment to his credit and must—

(*a*) produce evidence that he has attained the age of eighteen years, and in the case of an apprentice, has completed his apprenticeship ;

(*b*) have passed a prescribed medical examination of fitness ;

(*c*) possess such educational and other qualifications as prescribed ;

(*d*) be an efficient servant of good character ; and

(*e*) be in receipt of pensionable emoluments of not less than five shillings a day.

The period of two years is the minimum period of service in which a servant may qualify for admission to permanent employment, but in the discretion of the General Manager or the Minister the qualifying period may be extended. Such discretionary power has been exercised principally in the cases of staff employed in certain categories and the minimum period of qualifying service normally observed in the past has ranged from four to ten years, according to the nature of the employment of the servants concerned.

It was decided in 1940 to appoint staff in a temporary capacity only, and to make appointment contingent on the individual signing the War Contract of Service, in which it was stipulated that on the return from Active Service of members of the Railway staff, servants given temporary employment during the war were liable to have their contracts of service terminated.

When conditions returned to normal after the war, the position was reviewed and in 1946 the Minister of Transport, the Hon. F. C. Sturrock, decided to admit to the permanent staff all Europeans employed as temporary staff, including those who signed the war contract of service, providing they complied with certain conditions and had completed the minimum qualifying period of two years' continuous service.

This decision affected approximately 14,000 Europeans, and raised the ratio of permanent to temporary staff from approximately 60 per cent. to 75 per cent.

Non-European Staff.

The position of non-European servants was also reconsidered. This class of labour is part of the staff establishment for the normal requirements of the service, and it was decided that the services of non-European employees who had completed a certain minimum period of continuous employment and were engaged on duties of a permanent nature should not be dispensed with unless for disciplinary reasons or on the grounds of age limit, reduction in or re-organisation of staff, or on account of permanent ill-health or physical incapacity. Should the services of a non-European servant be dispensed with on the grounds mentioned, misconduct excluded, he is eligible, provided he has had at least five years' continuous service, to the payment of certain pension benefits for which provision is made in an Act of Parliament.

One of the primary reasons behind the revised policy here described is the desire to afford the greatest possible number of the staff, both European and non-European, the security of tenure which recent social legislation aims at providing for the population in general.

Security for the Staff.

The mainspring of security is the Railways and Harbours Superannuation Fund. Every servant between the ages of 16 and 45 years who has passed a prescribed medical examination and who has obtained a satisfactory certificate of fitness, is on appointment to the temporary staff admitted to membership and required to contribute to the Fund. The Railway Administration makes contributions on the £ for £ principle and accepts liability for the Fund's financial stability, the finances of the Fund being constantly under actuarial review. This has involved the payment of substantial sums annually to the Fund. The principal purpose is to provide annuities to servants reaching the age limit or retiring prematurely because of ill-health or re-organisation.

Non-Europeans and casual European servants are not admitted to membership of the Superannuation Fund, but are entitled to a gratuity if retired after completion of five years' continuous service, and to a gratuity or annuity if retired after the completion of at least fifteen years' continuous service. Contributions are not made by the staff.

The Railway Sick Fund.

A candidate for employment is required to pass a medical examination before appointment to the Service. On his appointment he becomes a member of the S.A.R. & H. Sick Fund to which he is required to contribute on a scale based on his rate of pay. The Railway Administration makes contributions to the Sick Fund on the basis of 16 per cent. of the members' contributions.

Membership of the S.A.R. & H. Sick Fund provides free hospitalisation, medical treatment and medicines for the railway servant and also for his wife, children and, in certain cases, other dependants, subject to certain conditions.

Casual servants, after twelve months' continuous service, are admitted to the full benefits of the Sick Fund, against the payment of contributions to the Fund.

Sick Leave.

Subject to the production of a medical certificate issued by a Railway Medical Officer an officer in temporary or permanent employment whose continuous service exceeds

two years, receives full pay during absence from duty due to sickness, while an officer in temporary employment, whose continuous service does not exceed two years, receives two-thirds of his salary.

Sick leave accrues on the basis of six weeks for each year of continuous employment in a permanent or temporary capacity as an officer or an employee.

In the case of an employee who has completed not less than two years' continuous permanent or temporary service, full pay is allowed in respect of the period of absence from duty due to sickness which exceeds one week, while an employee who has not completed two years' service receives two-thirds pay when absent from duty owing to sickness.

An officer is a person who is remunerated by salary calculated annually, and an employee is a person who is remunerated by wages calculated on an hourly, daily or monthly basis.

Staff Injured on Duty.

During periods of absence from duty as the result of accidents arising out of and in the course of their employment, European servants in temporary or permanent employment are granted full pay.

Casual servants (inclusive of Natives whose earnings exceed £13. 6s. 8d. per month) receive, in similar circumstances, compensation in terms of the Workmen's Compensation Act, 1941, which provides for the payment during periods of temporary disablement at the rate of 66⅔ per cent. of the workman's monthly earnings up to £20 per month, together with 37½ per cent. of the monthly earnings in excess of £20 up to £33. 6s. 8d. per month.

A Native whose monthly earnings do not exceed £13. 6s. 8d. receives compensation in terms of the Workmen's Compensation Act, 1941.

Casual servants who are eligible for the payment of sick pay, i.e. servants who have completed the qualifying period of twelve months' continuous service, are granted a special rate of sick pay.

House Ownership and Rent Rebate.

The Housing Scheme which was introduced in November, 1937, is a form of social security which is of considerable significance in the life of the country. Through this scheme railway servants are advanced money at a rate of interest fixed by the Minister (the present rate is 3 per cent. a year) to acquire their own homes. Because the loan to be advanced is a 100 per cent. loan, no initial deposit being required from the servant, the Administration insists that the property should be registered in its name until such time as the servant has liquidated his loan in full, the servant entering into a hire-purchase agreement with the Administration. Redemption payments range from 10 years up to 35 years. In the case of older servants they are permitted redemption periods which would take them up to 10 years beyond normal retiring age to redeem their loans, but upon retirement the outstanding amount on the loan must be liquidated by the servant from his commutation of annuity or other satisfactory medium.

Probably the most popular feature of the scheme among railwaymen is the accompanying insurance. By the payment of a single insurance premium which is added to the loan account, the amount outstanding on the loan, upon the death of the applicant at any time during the currency of his loan, is payable by the departmental insurance fund, and the dependants of the servant secure the house unencumbered in any way. No medical examination is necessary and all railwaymen are regarded as acceptable insurance risks. This is another form of social security contained within the orbit of the housing scheme.

The popularity of the scheme among railwaymen to-day when the housing shortage is greater than it has ever been in the country's history, is evidenced by the number of properties which have been acquired. It is anticipated that the

financial year will close with an expenditure of just over £2,000,000 under this head. Approximately one-third of the properties are building sites on which houses have been erected or are in course of construction under private contract.

The Rent Rebate Scheme was introduced in November, 1937. Under this, railway servants paying more than one-fifth of their basic emoluments in rent, are assisted by a rebate representing the difference between the rent paid and the said one-fifth, subject to a maximum of £4 per month. The increases in salaries and wages introduced in 1944 and 1946 have had the effect of reducing the amount payable in rent rebate, but the scheme continues to bring relief where high rents operate. Once a servant acquires a house under the House Ownership Scheme, he, of course, ceases to receive any benefits under the Rent Rebate Scheme.

Many members of the staff are given departmental houses at a rental of approximately one-sixth of the individual's salary or wage. It is impossible to build or provide a house for every railwayman and for this reason the other methods of meeting housing problems have been introduced.

Employment of Returned Soldiers.

Up to the present 13,000 Europeans and 8,000 non-Europeans, who volunteered for service with the Armed Forces and were not previously employed by the Railways, have been absorbed in the Railway Services. They occupy positions ranging from engineers to doctors, and from clerks to stewards. South African Airways have taken many of their personnel from the ranks of ex-servicemen. Two-thirds of the artisan apprenticeships for 1945, 1946 and 1947 have been allocated to the young men who, through joining the forces, were denied the opportunity of entering trades on leaving school.

The Railways have been one of the bulwarks of the Government's demobilisation machinery. The problem was scientifically tackled. During the war years promotion avenues for every railwayman on active service were kept open—the men received the promotion to which they would have been entitled had they remained at home, and they returned in the vast majority of cases to find better jobs waiting for them than those they held when they volunteered for active service. Not a single railwayman, who returned to duty, suffered in his civil career by going on active service.

When the Government announced its demobilisation policy the Railways extended similarly generous treatment to those men who, not previously in railway employ, joined the Railways. Active service was recognised as railway service for the purpose of determining rate of pay, leave privileges and pension benefits, seniority and other conditions of service.

The travel facilities usually extended by railway companies to their servants are provided also by the South African Railways, including annual free passes, privilege ticket orders, entitling the holder to travel at a quarter of the ordinary fare, and residential season tickets.

HEALTH AND WELFARE SERVICES.

The pioneering background of the history of railway development in South Africa is repeated in the story of the health and welfare services established and maintained for the benefit of its staff by the South African Railways. As the railway line penetrated ever deeper into the interior of the country health problems became more and more complicated. Disease had to be counteracted ; sanitary services, usually entirely absent or very primitive, had to be started ; and educational and social amenities had to be provided.

Many townships in the Union were originally railway outposts. A staff is a necessary preliminary to the establishment of a railway service and usually civilisation's advance guard consisted of a station master and his foreman, a track-maintenance gang, a pumper, a checker, and, at terminal points, a small engine depot and a workshop. Little groups of humanity, isolated in a country of big distances, consequently become established and have to be

looked after. Some form of social life has to be encouraged, and recreation has to be provided. These tasks have devolved to a great degree on the Railway Health and Welfare Department.

Experience has proved that the standard of service of the individual worker is dependent on a variety of factors—on home conditions ; on freedom from worry about the education of children ; and on opportunity for social intercourse and recreation. These objects the Railway Health and Welfare Services are intended to promote since health, welfare and social security services are directly related to staff contentment and efficiency.

The organisation responsible for the direction of these services has been allowed a very wide interpretation of its functions—which now include rehabilitative, preventive, and positive health and welfare measures as well as safety-first, physical education, and St. John Ambulance work—and its influence has spread far beyond the railway service. Indeed, it is now virtually a national enterprise, for one-eighth of the European population of South Africa is dependent on the railways for a livelihood and enjoys the benefits of the health and welfare programme.

Two conditions peculiar to South Africa make the work of the department different from similar services in Great Britain and many other European countries. The first is the existence of a large non-European population which out-numbers the white community by approximately four to one, and the second is the division of the country into large rural areas on the one hand and concentrated urban areas on the other. Both complicate normal public health control measures. The Natives (Africans), thousands of whom are employed by the Railways, are largely uneducated, a fact which produces an adverse reaction on the task of promoting for both communities an average economy and an average standard of hygiene knowledge such as more advanced countries can maintain. This state of affairs acts as a brake on the promotion of a high general standard of public health, and it also has an important bearing on the control of disease.

The Railway Health organisation was inaugurated in 1932, and now consists of a field force and five senior medical officers. Two avenues of training are open to the health staff : a recognised two-year course for the Royal Sanitary Institute examination (South African Branch) for health inspectors or a course of training provided by the Railway Administration. This second course lasts three years and consists of three months of intensive theoretical training at headquarters and nine months practical training in the field every year. On completion of the course, the candidate is a qualified health inspector, fumigator, lay vaccinator, physical instructor, and St. John First Aid demonstrator. The Administration also trains its own welfare staff.

The field work is divided into three phases :—

(*a*) Positive health measures to build up stamina and resistance to disease which is effected through such recreation schemes and leisure-time occupations as physical training, games, swimming, and holiday camps for children.

(*b*) Preventive measures to remove the cause of disease—malaria control, anti-rodent and plague work, the prevention and control of infectious diseases, disinfection and disinfestation for insect pests at staff quarters, other buildings, and rolling-stock, the sampling of domestic water supplies at railway villages, and similar activities.

(*c*) Consultative and inspectorial duties of a public nature for the improvement of the living and working conditions of the staff and their dependants and the security of the travelling public. Special attention is given to hygiene in the Catering Department and in the workshops and depots.

HEALTH.

Briefly summarised, the more important phases of railway health work in South Africa are as follows :—

Malaria.

Seasonal measures by the health staff cover all the affected areas on and adjacent to railway property. In addition to larvicidal measures, passenger rolling-stock, both road and rail, is sprayed with insecticide on services operating in and from infected areas, and all railway houses in these areas are fitted with screens. The resident staff are also equipped to carry out insecticidal work themselves. As a result, the incidence of malaria among railwaymen has dropped from 1,021 cases in 1932 to 157 in 1946, when 60,000 gallons of insecticide were used. The effects of malaria, which only a decade ago disrupted railway services on more than one occasion, have been reduced to negligible proportions.

Anti-Rodent Campaign.

International law demands the control of plague and rodents and the Railways are carrying out their obligations. The anti-rodent force employed by the South African Railways was reorganised in 1933 when the rodent-proofing of buildings and other anti-plague measures were adopted. Large sums have been spent on rodent-proofing at the ports, in grain and plague areas, and in large commercial centres.

Infectious Diseases.

Measures for the prevention and control of typhus, yellow fever, typhoid and dysentry, smallpox, diphtheria, tuberculosis, and other infectious diseases receive constant supervision, and close co-operation with the Health Department of the Union Government ensures swift action in tracing sources of infection and avoiding major epidemics. Fortunately, the Railways have never had to deal with a formidable outbreak of epidemic disease, and typhoid fever, amoebic dysentry, diphtheria, and scarlet fever, have the highest incidence.

Welfare.

Welfare services were started in 1938. The positive measures employed consist of adult education through the medium of lectures, demonstrations and films, combined with such activities as training courses in St. John Ambulance subjects, physical education for women and children, and group instruction in social responsibilities. Preventive measures are used to counteract the causes of social maladjustment such as juvenile delinquency, crime, poverty, and social back-sliding. The incidence of maladjustment and the possible causes are determined by community surveys. Welfare activities introduced on a large scale are briefly as follows :—

(*a*) *Nutrition Schemes.*—Vegetable gardening and the planting of orchards are encouraged by the women welfare officers, and the Administration also provides prizes for the best-kept vegetable gardens, fruit trees, and station platforms. At centres, where home cultivation is not practical, vegetable clubs have been started.

(*b*) *Homecraft Clubs.*—Homecraft clubs for adults are a popular form of organisation where women are taught the principles and practices of home making, where they are given an opportunity to utilise and develop creative ability, and where adult education is best introduced.

(*c*) *Childrens' Clubs.*—Physical education, homecraft, mothercraft, toymaking, St. John cadet classes, and agricultural instruction are arranged for the benefit of the child through the medium of these clubs.

(*d*) *Youth Clubs.*—These clubs cater for the adolescent and are intended to overcome the problems of youth in this most difficult stage of development. Social gatherings where suitable friends of opposite sexes may be met are the most important activities, but homecraft, mothercraft, physical education, and St. John Ambulance training are also included.

Railway Orphans in one of the Children's Homes.

Cafeterias, where the railway staff can obtain light meals, teas, coffee and other refreshments at reasonable prices, are operated by the Catering Department. A section of the Staff Dining Room, Johannesburg.

(*e*) *Clinics.*—The expectant mother, babies, pre-school children, school children, and adolescents receive continuous attention at these clinics, and the Administration also subsidises the salaries of midwives appointed as district nurses at certain centres to ensure that the wives and children of railwaymen do not suffer as a result of their employment at small and poorly developed centres.

(*f*) *Family Welfare Work.*—There are many problems in family life which are best dealt with privately in the home, and for this reason the South African Railways have appointed some 140 qualified women welfare officers who pay about 58,000 visits a year to the homes of railwaymen.

(*g*) *Non-European Welfare Work.*—The South African Railways also undertake community welfare work for the benefit of the non-European staff. Native, coloured, and Indian welfare workers have been employed under the supervision of the European staff to carry out group activities and family visiting among the wives and dependants of their own people.

Chapter V

SOUTH AFRICAN RAILWAY FINANCES

The South African Railways, with their ancillary services—Shipping, Airways, Road Motors and Ports and Harbours—are State-owned and are operated under the general control of the Minister of Transport. The Railway Administration, in which all these services are included, is self-contained; it controls its own finances and its own staff policy, and presents, through the responsible Minister, its accounts to the Union Parliament in an independent budget.

Control and operation are prescribed by Act of Parliament—Clause 127 of the Act of Union—which reads :—

> The Railways and Harbours of the Union shall be administered on business principles, due regard being had to the agricultural and industrial development within the Union and the promotion by means of cheap transport of the settlement of an agricultural and industrial population in the inland portions of all provinces of the Union.

Financial policy is laid down in the same Act, which requires that—

> So far as may be the total earnings shall not be more than are sufficient to meet the necessary outlays for working, maintenance, betterment, depreciation and the payment of interest due on capital . . .

The principles here enunciated make it clear that the tariffs of the Administration must take cognisance of the general policy of the Government and that the Railway Administration must in effect be conducted as a non-profit undertaking.

At the time of Union (1910) the Railway Administration's main activities covered the operation of railways and harbours only, but development in transport has added the operation of steamships, airways, aerodromes, road motor services, grain elevators and other subsidiary services to the original activities.

Capital.

The capital invested in this undertaking, the largest single business enterprise in the Union, is approximately £228,000,000 of which approximately £195,000,000 is interest-bearing. Of the capital which is not interest-bearing more than £13,000,000 represents assets which were obtained prior to Union from the revenues of the pre-Union railways, while nearly £18,000,000 of non-interest-bearing capital has been met from revenues earned subsequent to Union, mainly in respect of small capital assets which are financed from a Betterment Fund instituted in accordance with the Act of Union.

The South African Railways have no independent borrowing powers and their capital requirements are obtained from loans floated by the Union Government. In this matter the Central Government acts as the agent of the Administration, which pays interest and all other charges connected with the capital raised on its behalf. Capital is not redeemed since it may be said to be all revenue-earning. It is represented by assets and, of course, is subject to adjustment when assets are scrapped without replacement.

Renewals Fund.

The replacement of assets is provided for by a Renewals Fund (depreciation as provided for in the Act). Contributions to this fund are made annually as a charge against revenue and any replacement of assets is financed from the Renewals Fund.

Rates Equalisation Fund.

A further " fund " is maintained in accordance with section 128 of the South Africa Act which reads :—

> The Board (the Railway Board) may establish a fund out of Railway and Harbour revenue to be used for maintaining, as far as may be, uniformity of rates notwithstanding fluctuations in traffic.

The fund is called The Rates Equalisation Fund and it is used for the purpose of meeting deficits in years when normal revenue falls below normal expenditure. No provision is made for regular contributions to this Fund, which is entirely dependent on fortuitous surpluses. The Rates Equalisation Fund, therefore, is a reserve created in times of plenty to tide over periods of depression, but the Fund is kept within reasonable limits. At present it stands at approximately £8,000,000.

Financial Control.

The system of financial control is laid down in the Exchequer and Audit Act and provides primarily for control by Parliament. All revenue is paid into the Railway and Harbour Fund constituted under the Exchequer and Audit Act and may be withdrawn therefrom only under the warrant of the Governor-General. Expenditure requirements for a coming financial year are set out in detailed estimates which are placed before Parliament for approval. Parliament every year approves—through an Appropriation Act—of expenditure as estimated by the Administration. In this way the necessary control over expenditure is exercised by Parliament and should it transpire that the Administration has at any time exceeded its authority beyond the Parliamentary authority granted, the matter is reported to Parliament by the Controller and Auditor-General and it becomes necessary for Parliament to pass a further Act regularising any such unauthorised excess expenditure.

It will be observed that while the Railway Administration is subject to controls similar to those applied to State departments, it is detached from the ordinary Government procedure in that its funds are in no way controlled by the Government Department of Finance. In its estimates placed before Parliament sufficient detail is given to indicate the amounts required for maintenance of permanent way and works, maintenance of rolling stock, running expenses, traffic expenses, various subsidiary services, depreciation, interest, betterment fund, and other purposes. These are all defrayed from revenue, but, in addition, the Administration has to obtain Parliamentary authority for the expenditure from loan and betterment funds of the amounts required for any works which it wishes to undertake. Such works include the construction of new lines, the purchase of rolling stock and road motor vehicles, the extension of harbour works, the purchase of aircraft and any other services which have to be financed from loan funds obtained through the Treasury.

The Appropriation Bill for the current year ending 31st March, 1948, covers an expenditure of over £94,000,000, that is, nearly £77,000,000 for revenue services and about £17,000,000 for capital and betterment services.

Investments.

Surplus funds are placed with the Public Debt Commissioners for investment and it is within the powers of the Commissioners, one of whom is a member of the Railway Board, to decide in what way surplus funds shall be invested. Surplus funds cover various balances, such as balances to the credit of pension funds, renewals fund, rates equalisation fund and various minor funds held by the Administration. It is incumbent on the Administration, of course, to invest all trust funds such as pension fund moneys, but there is no legal obligation to invest the total balances in the rates equalisation, betterment or other funds.

Investments at the present time amount to £62,000,000 of which more than £41,000,000 is represented by pension fund balances. The interest—approximately 3¼ per cent. at present—

accrues to the Administration, but in terms of an Act of Parliament the pension fund is credited with interest at the rate of 4½ per cent. The difference is met from the revenues of the Railways.

Revenue.

Methods of raising revenue are not discussed by Parliament, but are left to the Administration which, through the Minister and Railway Board, may increase, decrease, amend or adjust rates to produce the required revenue.

Working Capital.

More than £10,000,000 is absorbed in the value of material held in stock for the working of the Administration. The greater portion of this amount is met from loan funds authorised by Parliament for the purpose, but any difference between such loan funds and the value of stock account is financed from floating balances not invested with the Public Debt Commissioners.

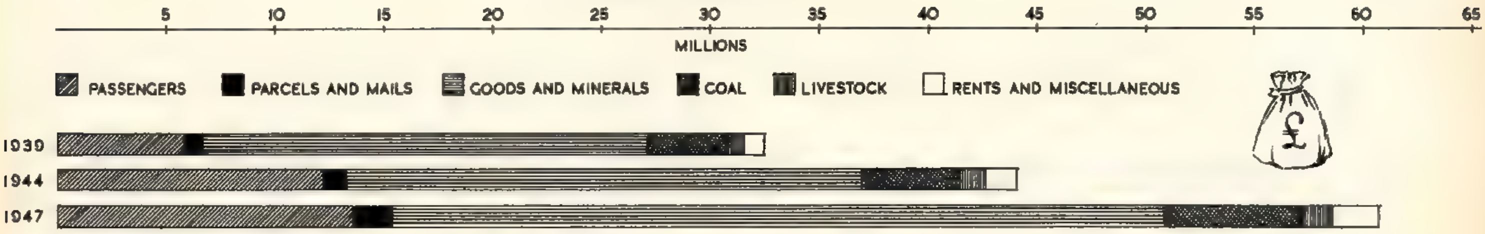
Final Accounts.

The accounting procedure requires expenditure to be accounted for, in the first stage, so as to show the ordinary working results in a revenue account, that is, revenue from passengers, goods, and other services, on the one hand, and expenditure on running, maintenance and traffic services, on the other. The balance of this account is carried forward to a net revenue account where other charges, such as interest, are brought to account, leaving a net result for railway services. A similar procedure is followed with other main services, i.e., harbours, shipping, airways and aerodromes. The final results of all these services are brought together in a net revenue appropriation account, and any surplus in this account may be used only for such purpose as Parliament may decide. It is in this last phase that Parliament may decide, on the recommendation of the Minister of Transport, to credit any surplus to the Rates Equalisation Fund. On the other hand, if a net loss is sustained, the Minister may decide to write this off against the Rates Equalisation Fund. If no balance is available in this fund, the Minister may employ other measures to produce a balanced budget in subsequent years.

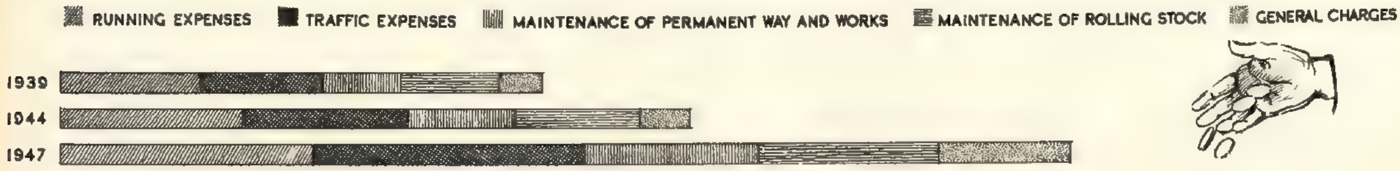
Audit.

The Controller and Auditor-General appointed by Parliament is responsible for auditing the accounts of the Railway Administration as well as those of the Central Government Departments. A separate report on railway accounts is presented by him to Parliament every year.

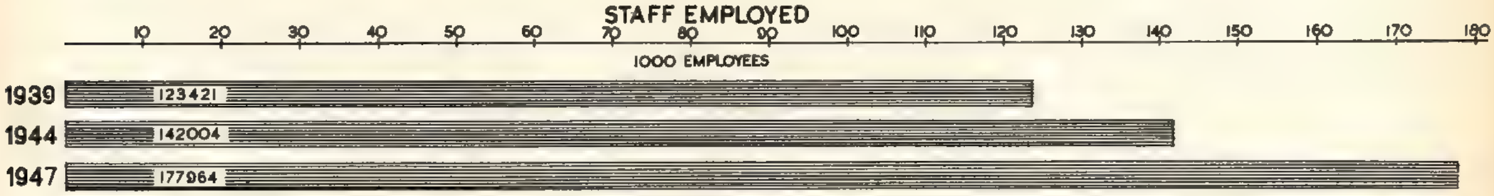
RAILWAY EARNINGS



RAILWAY WORKING EXPENDITURE



STAFF EMPLOYED



Labour costs, including all salaries, wages, overtime payments and costs of living allowances to the staff, will amount to £50,846,000 in 1947, as against £16,879,000 in 1936, but no cost of living allowances were payable. At the present rate the South African Railways spend £139,304 every day on salaries, wages and other allowances to a staff of 93,990 Europeans and 83,974 non-Europeans.

Chapter VI

COMMERCIAL AND INDUSTRIAL.

RAILWAY RATING POLICY.

Railway rates and tariffs follow the pattern of world practice to a large degree. The topography of the country; the location of industries and mines; the accelerated development of the interior; and the large and thinly-populated agricultural and industrial areas have all influenced the framing of the rating structure, which, in common with the general practice of railway companies in other parts of the world, is based on the principle of charging what the traffic will bear.

Agriculture has been of paramount importance to every government since Union and has enjoyed the advantage of low railway rates. Agricultural produce and farming requirements fall, broadly speaking, in the category of low-rated traffic, the policy applied here having for its object the maintenance of a strong farming community and the promotion of food production. It follows, therefore, that the vast bulk of goods traffic handled by the South African Railways falls within the low-rated class, which represents 85 per cent. of the volume of all goods carried, but produces only 41 per cent. of railway revenue from goods traffic. High-rated articles, of which clothing, boots and shoes, furniture, confectionery electrical goods, and spirits and other liquors are typical examples, represent 15 per cent. of the volume but produce 59 per cent. of the total revenue.

The system has come in for serious criticism from time to time, and it has been alleged that the farmer is being subsidised at the expense of other sections of the community. The policy has produced positive results, however. In a country of big distances like South Africa there is no efficient substitute for the long and cheap haulage on which agriculture is dependent and which only the Railways can supply. Cheap railway rates have had the effect of opening up large areas and of bringing these within the framework of the national economy. They have also promoted the creation of new sources of traffic for the railways.

The present rating structure is the result of a considerable period of evolution, and in framing tariffs railway revenue considerations have had to be reconciled with the interests of railway users in the agricultural, commercial and industrial fields. South Africa, in common with many other countries, has experienced a concentration of industrial development in a few large centres, and this has led to a demand for a special review of railway rates in order to encourage industrial decentralisation to some degree. But as the Minister of Transport, Mr. F. C. Sturrock, pointed out in the Union Parliament this year (1947), railway rates cannot accomplish miracles.

" Their influence, " he said, " is strictly limited. " " I do not share the view that a skilfully manipulated railway tariff can persuade two blades of grass to grow where only one grew before. Continuity in rating policy is desirable, since if it is a constant factor it relieves all sections of uncertainty. Adjustments are made from time to time, but every case has to be dealt with on its merits and judicious care has to be exercised in order not to disturb the delicate balance of the general industrial set-up. Disequilibrium and confusion will follow inevitably on ill-considered interference

with the production costs of established industry. ”

Against this background the rating structure of the South African Railways has grown. Under the existing system there is a discernible relationship between the rates on different classes of commodities, while the over-riding concern has been to relate tariffs to what the traffic can stand.

The average cost of transporting goods traffic by rail during the latest completed financial year was a little more than four-fifths of a penny per ton per mile, which means that if all the traffic had paid a rate based on this figure, sufficient revenue would have been earned to pay expenses, including interest on capital. This figure is accordingly an extremely valuable guide when considering the levels of the rates to be fixed for the conveyance of the various commodities but it is important to note that it represents an *average* cost.

The application of the principle of charging rates lower than the average cost of transportation in order to attract additional traffic has resulted in a marked expansion of railway business. As the total traffic of a railway increases the fixed and overhead expenses are spread over a greater number of units, and this makes it possible to maintain all railway rates, both high and low, at lower levels. But for the contribution to fixed and overhead charges which is made by the volume of low-rated traffic, which has been created in consequence of the application of the principle of charging what the traffic can stand, the average rate levels on the remainder of the traffic would probably have had to be increased.

The settled policy of the South African Railways has been to endeavour, through the tariff structure, to increase the volume of traffic as much as possible in the interests of the general economic development of the country. Since Union was established the progressive increase in tonnage carried over the railways has been phenomenal. In the last year prior to Union the tonnage carried was about 9,000,000. Ten years later (1920) the tonnage was 15,000,000. In 1930 the figure had increased to 24,000,000 tons and in 1940 to 32,000,000 tons, while in the latest completed financial year (1946), no less than 41,000,000 tons of goods and mineral traffic were transported over these railways, or four and a half times the pre-Union figure. These facts reflect the expansion which has taken place in the country's agricultural, commercial and industrial activities. Industry has been aided wherever possible by favourable rates on raw materials and on manufactured articles, especially where assistance has been necessary or desirable in order to enable the local product to compete with the imported article.

The following are examples of charges by the South African Railways for the conveyance of goods :—

Commodity.	Rates per ton of 2,000 lb.						
	100 Miles.	200 Miles.	300 Miles.	400 Miles.	500 Miles.	750 Miles.	1,000 Miles.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coal	0 6 4	0 9 4	0 11 11	0 14 6	0 15 10	0 19 7	1 1 6
South African Maize	0 9 4	0 14 6	0 19 2	1 3 7	*1 4 0	*1 4 0	*1 4 0
South African Wheat	0 9 4	0 14 6	0 19 2	1 3 7	*1 7 0	*1 7 0	*1 7 0
Soft Goods	3 11 8	7 3 4	9 18 4	12 0 0	13 16 8	17 3 4	19 8 4
Fancy Leather Goods	3 11 8	7 3 4	9 18 4	12 0 0	13 16 8	17 3 4	19 8 4

* Maximum rates. These also apply as a temporary measure to the corresponding imported commodities.

Passenger fares are divided into main line fares and suburban fares and provision is made for first, second and third class passengers. Special excursion fares are quoted in normal times for holiday seasons, while, except on the " Blue Train ", children are carried—

(*a*) free if under three years of age ;

(*b*) free if they have attained the age of three years and are under seven years and travel under family conditions in the care of a passenger holding an ordinary, concessionary or excursion ticket issued at adult's fare (but not short distance season tickets) ; and

(*c*) at half-fare if seven years of age and under sixteen years.

To encourage rail passenger traffic the South African Railways maintain a special passenger luggage service. Luggage can be booked and insured at departure points and first class passengers are allowed free transport of luggage up to 100 lb. ; second class passengers 75 lb. ; and third class passengers up to 50 lb. Children travelling at half-fare are allowed half these weights.

Fares are reasonable to a degree, as the following examples indicate :—

From Johannesburg.	To— Cape Town 956 Miles.	Durban 494 Miles.	Port Elizabeth 712 Miles.	East London 664 Miles.	Bloem-fontein 262 Miles.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
First Class Single	9 2 4	4 18 3	7 1 8	6 12 7	2 15 0
Second Class Single	6 1 10	3 5 6	4 14 4	4 8 0	1 17 2
Third Class Single	4 11 11	2 6 6	3 8 9	3 4 1	1 7 0
First Class Return	14 2 9	9 4 7	11 10 3	11 2 9	5 5 11
Second Class Return	9 8 8	6 3 0	7 13 6	7 8 6	3 10 5
Third Class Return	7 17 1	4 13 0	5 19 1	5 13 4	2 10 1

CATERING DEPARTMENT.

Two Railway hotels, one at Pretoria and the other at Cape Town, are to be built. With their completion the range of the Catering Department of the South African Railways will extend from the coffee-and-sandwich standard of the small rural station to sophisticated luxury and all its trimmings, and will include the many intermediate stages associated with travel—railway dining cars on trains, station restaurants and tea-rooms, staff cafeterias, and refreshment rooms at airports and harbours.

The development of the Railways and their related services has dictated the expansion of the Catering Department. Before the introduction of dining-cars, catering facilities were provided by contractors at wayside stations where passengers had to alight for meals and light refreshments. The practice still survives on some branch lines but, to-day, the standard practice is for twin vehicles, comprising dining-room, bar, kitchen, pantry and staff quarters to be marshalled in the centre of all main line trains.

The Railways operate 105 dining-cars, 33 departmental refreshment rooms, 270 sub-let concessions, three laundries, nine bedding stores, five staff cafeterias and seven airport tearooms, plus two catering stores for the supply of provisions to employees engaged on new construction work in areas where supplies

are difficult to obtain. Over and above these, there are catering and equipment stores in all the principal centres from which commodities are distributed to the refreshment rooms and dining cars. The Catering Department has a turnover of more than £2,000,000 per annum and employs a staff of 2,900 with an additional casual staff at peak periods of 600 persons. While the headquarters of the department are located at Johannesburg, there are, in addition, five district departments situated in the main centres of the Union, each in charge of a District Manager. The Department is under the control of the Catering Manager.

To impart a national character to the food served in dining-cars and restaurants South African produce is used, and many national dishes have achieved added distinction by being served on the South African Railways. Dishes such as Bobootie and Rice, many types of Breedies and other South African dishes have in this way been introduced to visitors from all parts of the world.

Meals in all dining-cars and all the principal restaurants are served on the table d'hôte system, and to obtain uniformity of service a standard menu for each meal has been drawn up for the guidance of the staff, thus :—

Breakfast 2*s.* 9*d.*	*Luncheon* 2*s.* 9*d.*
Fruit Juice	Soup
Cereal	Fish
Fish	Entree
One Entree	Joint or Grill
Bacon	Two or four Cold Meats
Eggs to order	Sweets
Two Cold Meats	Cheese and Biscuits
Toast and Preserves	Dessert
Tea or Coffee	Black Coffee

Dinner 4*s.* 0*d.*
Soup
Fish
Entree
Two Joints
or
One Joint and Poultry
Sweets
Cheese and Biscuits
Dessert
Black Coffee

The number of meals served during 1946 exceeded 4,000,000, and nearly £1,000,000 was spent on the purchase of foodstuffs and other commodities.

A special service is provided for non-European passengers, who are served by their own people. Non-European trains, such as those conveying parties of Bantu (Africans) between the recruiting areas and the mines, have special type restaurant cars attached to them. The refreshment cars have a kitchen for the supply of hot drinks and cooked meats, but the remainder of the vehicle is fitted up as a shop with counters and shelves.

The Catering Department also supplies refreshments at seven airports as well as on the aircraft operated by the Railways between the Union and the United Kingdom and on certain internal air services.

Another branch of activities deals with the supply and laundering of bedding for passengers and staff rest-rooms. Approximately 4,500,000 beds are handled annually, and the three laundries deal with more than 13,000,000 articles every year.

Beds are supplied to passengers at the rate of 3s. 6d. per unbroken journey of one or more nights. Each main line train is provided with a special staff of " bedding " boys who, besides attending to the laying of beds, are also responsible for the cleanliness of compartments, retiring rooms and corridors during the journey.

A recent development is the acquisition of cellars for maturing and bottling selected South African spirits and wines. The cellars are under the charge of a viticulturist who tests all liquors delivered to the cellars and is responsible for their blending before being bottled under South African Railways labels. In 1946 the Railways spent nearly £100,000 stocking their cellars.

STORES DEPARTMENT.

The Stores Department of the South African Railways with headquarters in Johannesburg, has become one of the largest single buying organisations in South Africa. Turnover

increased from £8,778,417 in 1910 to £40,527,799 in 1946, and there are now seven major supply depots, all in close proximity to the mechanical workshops of Cape Town, Uitenhage, East London, Bloemfontein, Durban, Germiston and Pretoria. Other depots have been established at Mafeking, Pietermaritzburg and Windhoek, while thirty smaller stores, in different parts of the Union, carry stocks for minor repairs to locomotives and rolling-stock in traffic. The total staff in the Stores Department, including the head office staff at Johannesburg, numbers 3,600.

Railway requirements, with certain minor exceptions, are bought under a system of public tenders, and quotations have to be submitted to the South African Railways Tender Board, which was constituted in its present form in 1944, and which consists of a full-time Chairman, four senior Railway officials representing different departments, and one representative of the Association of Chambers of Commerce and one of the Federated Chambers of Industry. The Board is advised by the Commercial and Technical officers of the Railways and has its own staff.

While the system of public tenders is generally employed, many of the requirements of iron and steel products—such as structural sections, heavy rounds, merchant bars, rails, reinforcing rods, plates, galvanised, corrugated and flat sheets and pig iron—are purchased direct from the South African Iron and Steel Corporation, in terms of a standing agreement.

The main commodities bought almost exclusively in the Union are coal, iron and steel, paints and oils, tyres and tubes, cement, timber for coach-work and other purposes, and catering supplies such as groceries, meat, fish and vegetables.

Since a large proportion of the manufactured requirements of the South African Railways has to be imported from Europe and America, there is a considerable time-lag between the placing of orders and the receipt in the Union of the finished product. Orders have to be placed well in advance and this requires a good intelligence service, based on complete records of consumption.

In terms of the policy of the Union Government the South African Railways give a high degree of preference to South African products, buying and ordering from Union manufacturers and merchants wherever possible. The Railways are by no means independent of foreign markets but the encouragement of local industry has paid dividends both to the Railways and to the country. In 1910, total purchases in the Union amounted to only £1,860,965, out of a total of £3,877,226, while in 1946 the Railways spent £12,884,520 (65·9 per cent. of its total purchases) in the Union—and this at a time when many commodities were in short supply.

At present the Railways spend £35,300 every day on purchases in the Union, and orders placed in South Africa in 1946 included goods wagons (£1,543,063) ; motor vehicles (£871,824); and provisions (£596,094). South African manufacturers have recently been awarded contracts for the supply of goods wagons to the value of more than £6,000,000.

The Catering Department of the Railways, with an annual turnover of more than £2,000,000, buys 96 per cent. of its requirements from South African producers and merchants.

In the Union a staff of technically qualified officers is attached to the Stores Department to inspect locally-manufactured products and supplies, while orders placed with overseas producers are subject to inspection by the South African High Commissioner in London or the Union of South Africa Government Supply Office in Washington, U.S.A. In this way it has been possible to ensure that the commodities supplied are strictly in accordance with specifications and drawings.

The Stores Department is forced by circumstances to carry large stocks and the total value of stores on hand at the end of 1946, was £8,500,000, indicating the magnitude of this Railway Department.

RAILWAY POLICE.

The South African Railways maintain a police force known as the Railway Police. The men are recruited in the Union and are trained at the Railway Training College in ordinary police duties, plus a thorough grounding in the special work they have to undertake ; the guarding of railway property and of goods carried by the Railways, the South African Airways, the Railway Road Motor Services, and the Railway Shipping Services.

The beat of the Railway Policeman is an enormous one. It covers thousands of miles of railway track, plus all the stations, sidings, airports and harbours in a country of more than 790,219 square miles. Public property in Railway custody has to be protected and the rules and by-laws of the Railways have to be enforced. The Police branch, in short, represents a comprehensive insurance policy taken out and maintained in the interest of the railway-user.

The Railway Police Department is part of the Commercial set-up and is one of the divisions under the general control of the Commercial and Industrial Manager. Forty-seven commissioned officers and 2,289 other ranks are on strength with more than 200 recruits at present undergoing training. They are equipped and maintained on standards equivalent to those of the South African Police Force, and have similar powers of arrest, though their area of jurisdiction covers only railway property, but all cases are tried before the competent courts of the country.

Headquarters of the force are at Johannesburg, with system headquarters on each of the nine systems. There are 178 system outposts, covering railways, airports and dock areas throughout the Union and South-West Africa. The force was started many years ago, but received full recognition as a police force, with full powers of arrest, only in 1916. With the growth of the Railway system and other associated services, the duties of the Force have correspondingly increased, and in 1946, prosecutions numbered 21,138. South Africa, in common with all other countries, has had to face an increase in crime, which on the Railways is expressed chiefly in pilfering from goods sheds, harbour areas, and trains. The scarcity of commodities, the existence of a black market, and the high prices obtainable for goods in short supply, have combined to make pilfering a profitable business, and have added greatly to the difficulties of control.

New methods were introduced a few years ago—the training of staff was revised and extended to include police, checkers and clerical assistants ; supervision was intensified ; the Railway Police Force was brought up to establishment strength ; and a Claims Prevention section was created. The results have been very encouraging.

In the period April to October of this financial year, as compared with last year, claims paid were reduced from 0·63 per cent. to 0·49 per cent. of the net revenue earned, an improvement of nearly 20 per cent. More than 20,000 prosecutions were instituted and goods to the value of £16,000 were recovered.

Besides guarding public and railway property, the Railway Police have many other functions to perform. One of the least spectacular of these is the recovery of articles lost or forgotten by the travelling public on railway premises, in trains, in waiting-rooms, and at stations. In the first eleven months of last year no fewer than 42,424 forgotten or mislaid articles were recovered.

FRUIT EXPORT.

More than 6,000 miles separate the orchards of South Africa from the export markets in Europe and America. It may be three weeks or more after picking before the fruit is eaten. With such a delicate and perishable product it follows that the whole export structure is ruled by the factors of time and distance. These can be overcome only by transportation

Grain Elevator, Cape Town, with Table Mountain in background.

The Largest Pre-Cooling Store in the World.
Fruit Awaiting Export at Cape Town.

under conditions which will preserve quality and appearance.

This is now a commonplace achievement. To-day, when a bunch of South African grapes reaches the consumer's table in London or Stockholm, the fruit is as wholesome and tasty as if it had just been picked in a Paarl vineyard. Helping to render this possible, the South African Railways have made one of their most important contributions to the economic stability of the Union's deciduous and citrus fruit industry.

South Africa's first fruit orchard was planted at the Cape 294 years ago to help provision the ships of the Dutch East India Company plying between Holland and the Far East. The first ship supplied from this orchard started an export trade which has since grown to nearly 10,000,000 cases of fruit in a single year.

One single influence, far more than any other, accounted for the transformation, and that was the development of refrigeration and the erection of pre-cooling stores at the principal ports. The pre-cooling stores built by the Railways and the introduction of refrigerated and ventilated fruit trucks have enabled the farmers of the Union to establish an industry which is now second to the wool industry in its value to the country.

The relationship between the expansion of the pre-cooling services at the ports and the growth of the fruit export trade is best demonstrated by the developments which have taken place at Cape Town, where most of the fruit is shipped. The growth of the Union's fruit exports began with the opening of the first cool chambers in 1915. The impetus this gave to the export of fruit was obscured while the war was in progress, but from 1919 to 1925 the annual exports climbed rapidly from 3,783 tons to 45,380 tons, an increase of more than 40,000 tons in six years. In 1925, the Railways opened a new and much bigger system of cool chambers on the East Pier, and in the next ten years the exports rose to 205,396 tons a year. A new store was completed in 1936, and in 1939, the growers shipped 357,000 tons, an increase of about 150,000 tons in three years.

To-day, Cape Town's pre-cooling stores, which cost £414,000 to build, are the largest in the world, and the method of handling the fruit is the best which contemporary science can devise, as shown by the superior quality of the fruit at the end of its long voyages. More than 65,000 packages of fruit, measuring 1,400 shipping tons, have been received and stored in a single day. The fruit is usually shipped as fast as it is received, subject only to the time required for pre-cooling, and as many as four ships can be loaded simultaneously.

The principal pre-cooling store at the Duncan Dock is a shed 875 feet long and 60 feet wide with 25 cooling chambers, capable of storing 7,000 tons of fruit. The cooling chambers occupy the centre of the shed, extending from one end to the other like a row of great iceboxes. They are flanked on one side by the unloading platform, where the fruit trains pull in, and on the other by the shipping corridor, where the fruit eventually emerges along-side the wharf to be lowered into the waiting ships.

In the whole of this process, the fruit is handled only twice—once in the unloading of the trucks and a second time when it is packed into the ship's hold. The elimination of handling is based on the use of flat trolleys, known as skids, each capable of carrying about four tons of fruit. When the trucks are unloaded, the boxes of fruit are packed on to these skids, and until they are removed in the ship's hold the fruit remains untouched. This method was evolved in South Africa and is without parallel anywhere in the world.

The Railways operate more than 2,000 ventilated fruit trucks, embodying the latest principles of fruit transportation, and a further 2,000 are on order. A double roof, with the air circulating in between, protects the fruit

from the direct rays of the sun, and although the air moves freely through the truck, neither dust, rain, nor insects can reach the contents.

GRAIN ELEVATORS.

The production of maize, kaffir corn (millet) and wheat represents an important phase of South Africa's agricultural economy, and the handling and storage of these commodities are so closely interwoven with transportation that the Railways have had to provide a network of grain elevators, stretegically located throughout the grain belts, and at the principal ports. The existing system consists of 35 country elevators varying in storage capacity from 1,700 tons to 5,800 tons, with a total capacity of 110,900 tons, plus two port elevators, Durban and Cape Town, with a storage capacity of 42,000 and 30,000 tons respectively, giving a grand total for all elevators of 182,900 tons.

Grain elevators were first mentioned in 1911, but the present system did not come into operation until 1924. The capital cost was £2,600,000 of which £1,112,000 was spent on the erection of 35 country elevators and £1,488,000 on the two port elevators. For grain transportation the South African Railways have available 2,000 steel grain bogies of 40 tons capacity, but this number will be increased as soon as new stock becomes available.

Country elevators are capable of handling 15,000 tons of grain per working day of eight hours, while each port elevator can handle 4,000 tons inward from grain trucks and 8,000 tons outward into ships per working day of eight hours.

All grain deposited in the elevators is pooled for bulk handling and storage according to grade, and elevator receipts, specifying the nett weight and grade of grain, are issued to grain owners in terms of the Agricultural Warehouse Act (Act No. 42 of 1930) and subject to the tariffs and regulations of the South African Railways.

When the elevator receipts are surrendered together with covering delivery instructions, all charges, including railage, elevator tariff and storage accruing on the grain are collected. The receipts shew the point from which railage is chargeable and also the date from which storage charges have to be paid.

One per cent. of the weight of grain deposited is deducted from the intake weights, after the grain has been cleaned and graded, to cover wastage in handling and drying out of grain. The grading regulations prescribe a maximum moisture content of 12½ per cent. in the case of maize, and 13 per cent. in the case of wheat, for acceptance into elevators, and on the whole experience proves that these deductions are sufficient to cover wastage in handling and drying out of the grain during the seasonal storage period, which seldom exceeds 10 to 12 months.

The scale of tariffs and storage charges in operation was based on an expected annual tonnage turnover of about 600,000 tons, of which at least 400,000 tons would be exported, and the balance delivered for local consumption in the Union. This tonnage turnover is equal to about five-and-a-half times the storage capacity of the country elevators but, unfortunately, on five occasions only since 1924 has this tonnage been approached or exceeded. The financial results in operating the system have consequently been disappointing. The accumulated working loss since the inception of the System up to the 30th June, 1946, amounts to £984,611.

The essential function of the elevator system, and the main purpose for which it was established, is the economical and rapid handling of grain for export in bulk. The adverse financial results are due mainly to the fact that the Union's maize industry has not developed to the extent anticipated when the adoption of the elevator system was agreed upon. The two main factors preventing such development are—

(*a*) unfavourable weather conditions for maize culture on a consistently large scale ; and

(*b*) depressions in the world's market prices for maize and, latterly, the restrictions imposed by war conditions.

The incidence of these factors has caused the system to become somewhat unbalanced. The larger proportion of the original capital expenditure was incurred for the specific purpose of attaining the highest degree of handling capacity—but this in actual practice has proved to be quite unnecessary. Inland storage capacity has become a far more important item.

Experience has proved that the most efficient and economical method of dealing with any large volume of grain traffic is to handle it in bulk, but no elevator system can be made to pay its way by storing the same grain for an indefinite period, even at the maximum economic storage charge which such grain can bear. There must be regular in and out movement to ensure maximum tonnage turnover for the bulk handling and storage system, consistent, of course, with the volume of grain offering for the system in the various producing areas, in order to secure the more remunerative revenue to be derived from the elevator handling service as distinct from the storage service.

Another important consideration necessary to ensure successful operations is that all large consumers of grain, such as milling concerns, should adopt the bulk handling and storage system and should provide suitable plant for the purpose, thus ensuring maximum deliveries in bulk from the elevator system. Unfortunately, this aspect has been a most disappointing feature of elevator operations in South Africa, as up to the present very few of the larger milling concerns in the Union have adapted their plants to bulk handling and storage of grain. The bulk handling and storage system is an efficient and economical method of preserving stored grain in sound condition, and from experiments made it has been found possible to maintain maize and wheat in the elevator system in perfectly sound condition for upwards of two years.

Another feature of elevator operations in the Union is the fact that all grain deposited in the elevator system enjoys favourable railage rating facilities from original railing point to ultimate destination, via the district or regional grain elevator into which the grain is deposited. This facility represents an important economic concession to the grain industry of the Union.

The system of working elevators in South Africa is unique in the world, in that the whole control, including the grading, warehousing, transportation, shipping and delivery of all grain dealt with through the elevators is vested in one authority—the South African Railways. This principle of centralised control is an important economic factor in any grain producing country, since it affords ample scope for co-ordination of effort which in turn promotes efficient and economical working as compared with other systems where control in the various phases connected with grain handling is divided between two or more authorities.

PUBLICITY AND TRAVEL DEPARTMENT.

The Publicity and Travel Department started in 1910, and is responsible for all publicity, including press, poster, film and booklet advertising, photographic and film work ; advertising in collaboration with local authorities ; the publication of a railway magazine,; the management and control of bookstalls ; the control of all commercial advertising on railway premises, and the control of automatic machines.

For administrative purposes the Department is divided into two distinct branches—a publicity branch dealing with all general publicity and, since 1930, tourist activities ; and a commercial branch concerned largely with bookstalls and commercial advertising.

Besides ' joint ' publications the Department produces publicity matter of a purely railway nature such as posters and folders advertising railway services, annotated time-tables, and

a wide range of publications drawing attention to South Africa and to national tourist attractions.

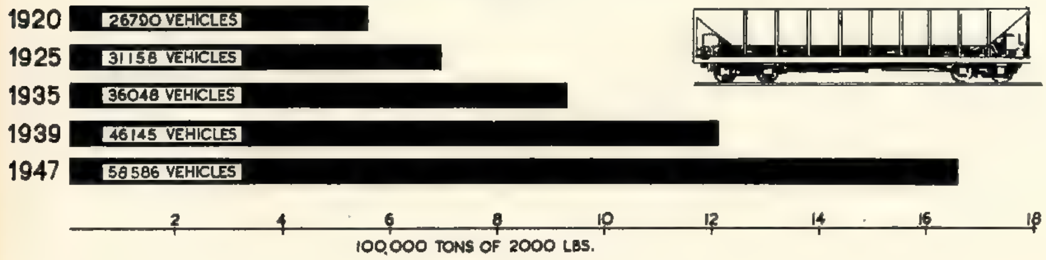
Apart from encouraging travel in the Union the Department has, in the past, been responsible for encouraging travel to the Union. Advertising overseas is a most important feature of its activities, and representatives are stationed in London and in New York.

The tourist branch is a revenue-earning branch and its expansion is reflected in the increase of its earnings which amounted to £59,967 in 1930–31 and to £337,964 in 1946–47.

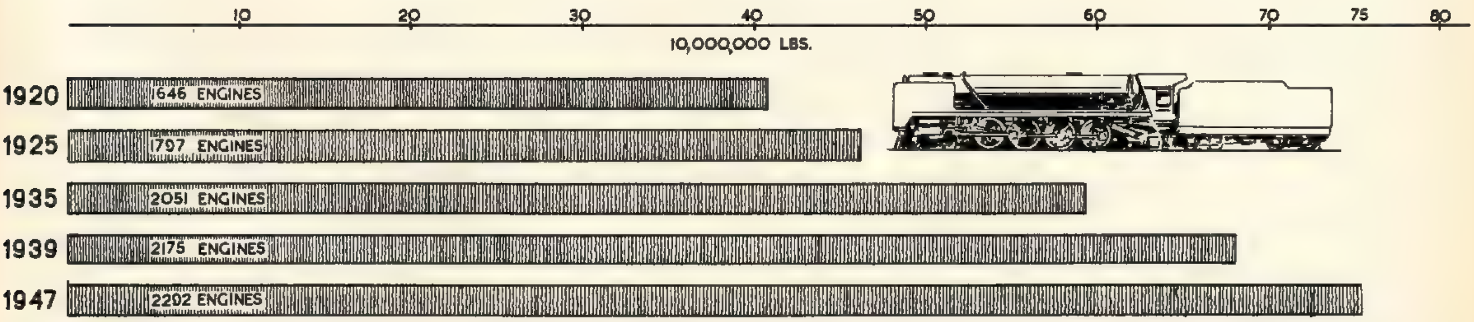
Bookstalls.

At the time of Union, bookstalls on railway stations were operated by private enterprise, except in Natal, but as existing contracts expired the business was taken over by the department.

GROWTH OF AGGREGATE CARRYING CAPACITY OF GOODS STOCK
(MERCHANDISE STOCK)



GROWTH OF TRACTION POWER



Chapter VII

ENGINEERING

CIVIL ENGINEERING DEPARTMENT.

The days have passed into history when Civil Engineers, recruited from the Railway Companies of Great Britain and the Netherlands, and from military units in India and elsewhere, rushed over the mountains and across the plains of South Africa in their search for suitable railway routes. These pioneers of the modern Civil Engineering Department of the South African Railways worked under the spell of a tremendous urgency. There was neither money nor time to build tunnels ; so they went round mountains. Steep gradients were overcome by circuitous deviations and the bridges flung across the rivers were designed to carry comparatively light loads.

The railway was the only weapon which could conquer the distances of Southern Africa and was the sole solution for the clamant transport needs of a country which in a space of considerably less than half a century had discovered diamonds, gold and coal, and had multiplied its population many times. The ports had to be connected with the wealth of the interior in a hurry, and railway construction followed almost on the heels of survey parties.

To-day there is a railway network of 13,483 route miles. Johannesburg is within little more than a day from Cape Town, and the formidable mountain barriers between the Transvaal and Natal are now traversed overnight in comfort and speed. The work of the Civil Engineering Department has not come to an end, however. In many ways it has grown more complex. The early routes have to be re-surveyed to meet the more searching needs of the present day. With the development of the steam engine and the electrification of important sections, heavier tracks have had to be laid and bridges have had to be strengthened. The demand for greater speed has made the elimination of unnecessary curvature imperative and is dictating a long-range policy of tunnel building to overcome slow running-times and to promote the efficient use of engine power.

In the early stages of railway development the Cape Government Railway adopted ruling gradients of 1 in 40, uncompensated for curvature of a minimum radius of 330 feet, while the Natal Government Railway adopted ruling gradients of 1 in 30 uncompensated for curvature of 300 feet minimum radius. In order to climb over the Drakensberg mountains to the Transvaal at Boscobello and the Orange Free State at Van Reenen, reversing stations were built. The Netherlands Company, building the line from Lourenco Marques to Pretoria, adopted ruling gradients of 1 in 50 uncompensated with a minimum radius of curvature of 492 feet, and in order to climb the escarpment from Waterval Onder to Waterval Boven introduced a rack section of 1 in 20, which enabled the line to rise 682 feet in three miles. Both the reversing stations and the rack sections have been discarded.

The accompanying illustrations of the main line from Durban to Johannesburg and the Cape Town–Hutchinson section of the Cape Town–Johannesburg main line are enlightening, and give a very good idea of the difficulties which were encountered in construction.

The programme of improving on the original

locations has been carried steadily forward. Very soon after Union a start was made by deviating the section Mooi River–Estcourt in Natal, and work and improvements have been carried out almost continuously since then so that to-day the line between Durban and Volksrust is almost entirely a new one. The present main line from Durban to Johannesburg has a ruling gradient of 1 in 60 against coastwise traffic and 1 in 50 against inland traffic with a minimum radius of curvature of 488 feet, except at a few places where the line has not yet been deviated. At the same time as improvements to location were taken in hand, heavier track was laid to enable more powerful locomotives to operate, while between 1922 and 1937 the main line from Durban to Volksrust was electrified.

The improvements to the main line from Cape Town to Johannesburg have not been as spectacular as those in Natal but many improvements have taken place, and express passenger trains are able to maintain an average speed (including stops) of about 40 miles per hour over about 550 miles out of the total distance of 956 miles.

Some idea of the progress made is indicated in the scheduled times for passenger trains. In 1910 the journey from Durban to Johannesburg, a distance of 494 miles, took 24 hours whereas to-day it has been reduced to 16¼ hours. In pre-Union days it took 36 hours to cover the 956 miles from Cape Town to Johannesburg. This has been reduced to 26½ hours.

The Cape Eastern Main Line from East London to Burghersdorp, a distance of 243 miles, is another line which deserves special mention since major improvements have been and are still being carried out there. The new line has a ruling gradient of 1 in 50 compensated with a minimum radius of curvature of 716 feet as against the original line of 1 in 40 uncompensated and 330 feet radius curves. As deviations are completed they are brought into use.

Permanent Way Development.

As far as track is concerned, developments on the South African Railways since the date of Union in 1910 are illustrated by the following figures :—

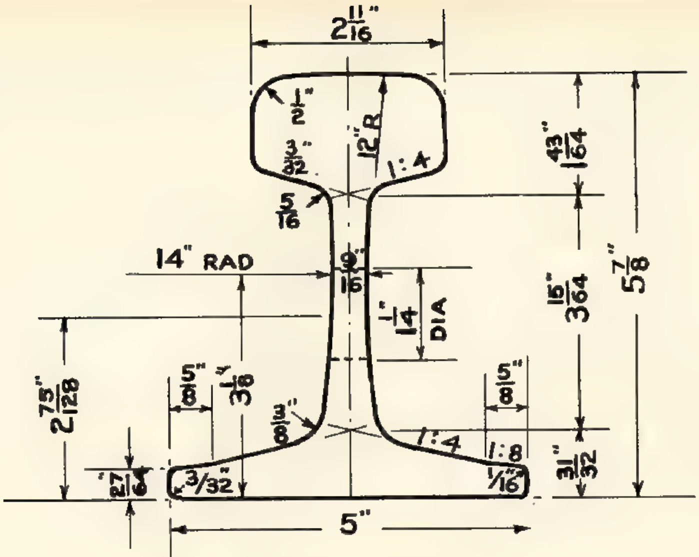
Weight of Rails in lb. per Yard.	1910.		1946.	
	Route Miles.	Per-centage.	Route Miles.	Per-centage.
Lighter than 59 lb.	1,142	15·1	1,936	14·4
59 lb. to 61 lb...	4,422	58·3	5,291	39·4
75 lb. to 85 lb...	2,012	26·6	3,797	28·1
96 lb..........	—	—	2,459	18·1
Total.....	7,576	100	13,483	100

As traffic increased, heavier engines were required necessitating heavier rails. At the date of Union the permissible axle-loads were 12½ tons for 60-lb. rails and 16 tons for 78–80-lb. rails whereas the present permissible axle-loads are 22 tons for 96-lb. rails, 18 to 21 tons for 80-lb. and 13 to 15 tons for 60-lb. rails.

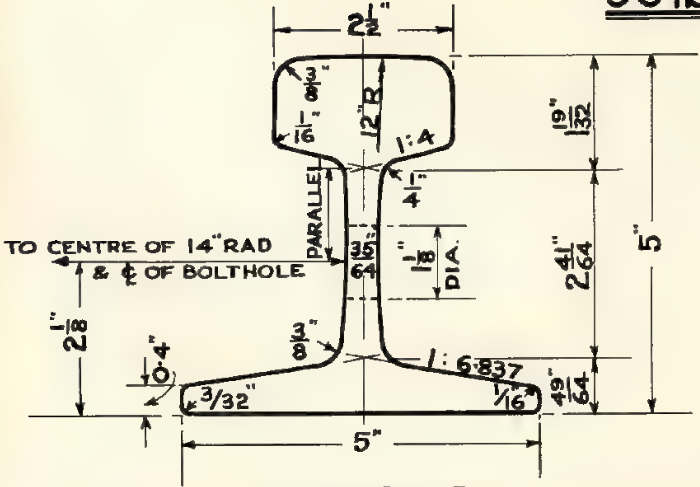
The tracks are classified into various classes according to the weight of rails, number of sleepers per mile, quantity of ballast per mile, and the maintenance labour strength. The permissible axle-load and maximum permissible speed on straights are specified for each class of line. Class I consists of 96-lb. rails, 2,376 sleepers per mile and 2,200 cubic yards of ballast per mile and is suitable for 22 ton axle-load, and a maximum speed on straight track of 60 miles per hour. At present the mileage of Class I line is not great and the main lines are suitable for a maximum speed on straights of only 55 miles per hour. Lower speeds are applicable to lower classes of line.

Rail Section.

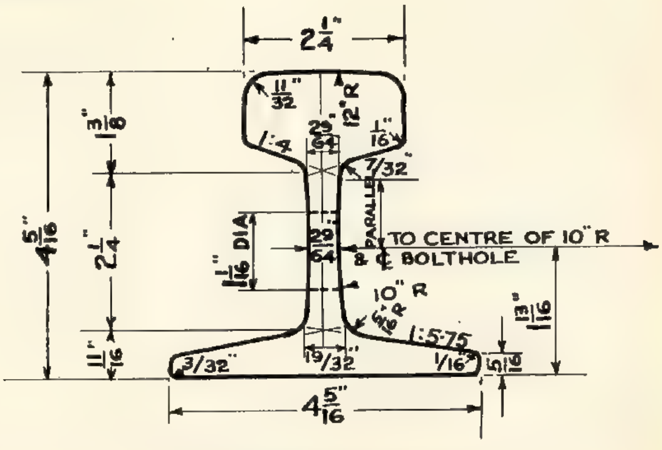
Before Union, some of the railways had adopted British Standard Sections, although they had in addition special sections of their



96·lb S.A.R.



81·lb S.A.R.



61·lb S.A.R.

own, but in 1911 the South African Railways adopted British Standard Sections for all lines.

Shortly after the opening of the electrified section in Natal, breakages in the web of the 80-lb. section were found, and the 85-lb. S.A.R. section of rail was introduced in 1926. This section was 5 inches high with a 5 inch flange to enable it to be used with the 80-lb. British Standard Section chairs and soleplates and steel sleepers, but it had a heavier head, and the main feature was the "Oaktree" web; that is, the web is thickened out at the junctions with the head and with the base.

In 1929, in order to increase the permissible axle-loads the 96-lb. South African Railways Section was introduced. This section has the "Oaktree" web, is $5\frac{7}{8}$ inches high, and has a 5 inch flange to enable it to be used on the standard 80-lb. chairs and soleplates and steel sleepers. (This rail served as the model from which the heavy American Railroad Engineering Association rails were developed).

Subsequently, the 81-lb. South African Railways Section was introduced in 1934, and the 61-lb. South African Railways Section in 1943. Both these sections have the feature of the "Oaktree" web, and with the exception of the fishplates are interchangeable with 80 and 60-lb. British Standard Sections.

The 96-lb., 81-lb., and 61-lb. sections are the present standard sections of rails (see illustration). The standard length of rails is 40 feet, but 61-lb. rails, which are imported, are ordered in 33-feet lengths. Since the introduction of the 96-lb. section in 1929, 2,644 track miles have been laid. This mileage would have been considerably greater had it not been for the outbreak of war in 1939.

Rail Joints.

At the time of Union the various Railways were using both 4 and 6-hole flat and angle fishplates.

In 1922, it was decided to adopt the 100 per cent. fishplate. This plate projects below the flange of the rail and the section modulus of the two plates is approximately the same as that of the rail section. The angle and 100 per cent. plates are the standard plates now in use.

Also in 1922, the Administration commenced pressing out worn plates to fit the average shape of the rails. This resulted in these enlarged plates having the top fishing surface shaped to a bow section, the bottom fishing surface being straight. These enlarged plates have since been used very extensively for re-conditioning track with battered rail ends and worn fishing surfaces.

In 1925 it was decided to change over to four-hole plates, and this is the present standard.

Since 1938, the South African Railways have adopted the policy of using 120 feet rails (made by the flash-butt welding of 40 or 33-feet rails).

Experiments are also being conducted on longer lengths of rails. In addition, in tunnels all joints are welded. This policy has, therefore, eliminated a large number of joints.

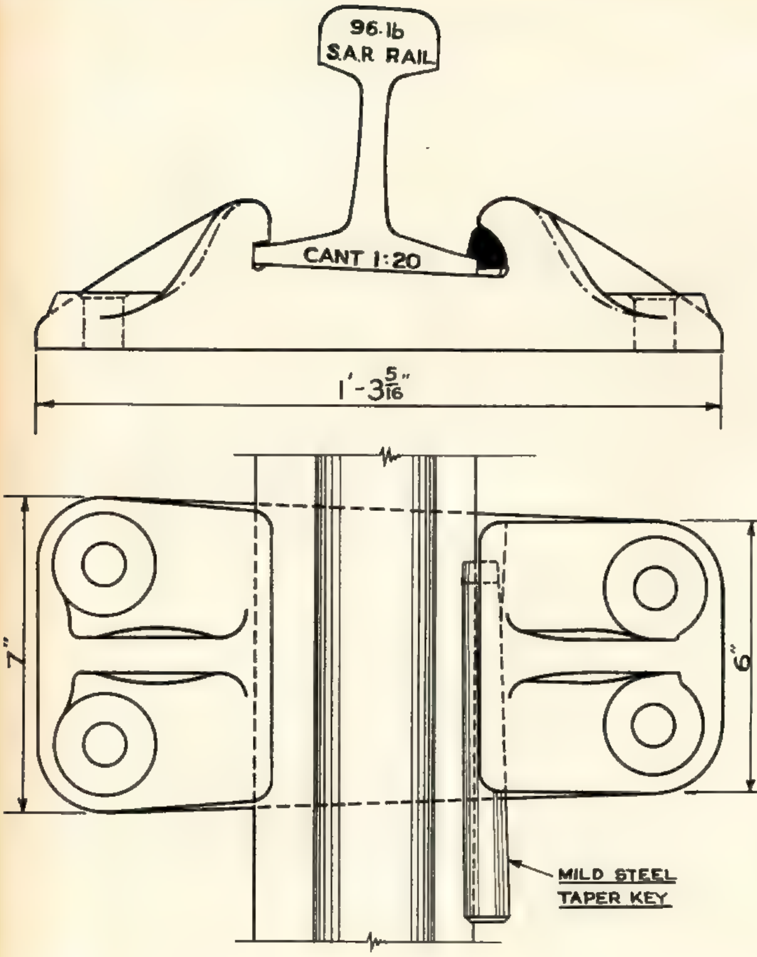
In common with other Railways throughout the world, South Africa is conducting experiments on various types of fishplates with a view to solving the rail-joint problem.

Chairs and Soleplates for Wooden Sleepers.

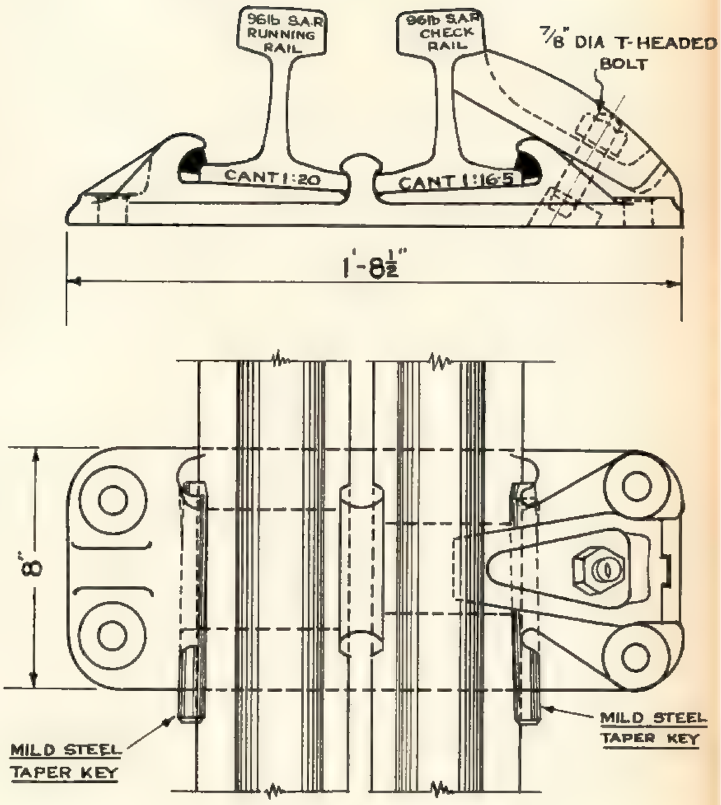
The present standard practice of laying rails, which has been used for many years, is to lay the rail either on a chair or soleplate and to secure it to the sleeper by means of coachscrews.

With the 78-lb. Natal Government Railways rail used in Natal prior to Union, a cast iron chair with a spring key was used. A large number of these chairs are still in use, but the spring key was not satisfactory and has been replaced by a special taper key.

In 1921, the first steel taper key was developed for use with 80-lb. rails, the chair being so designed that the key could be driven from either side of the chair. This key and chair underwent slight modification, and the present standard was developed in 1925. This chair and key can also be used with 96-lb. rails, and a similar chair was evolved for 60-lb. rails using



80lb CAST IRON CHAIR



96lb CAST STEEL CHECK CHAIR & BUTTRESS
ON WOODEN SLEEPERS

the same taper key. The key not only holds the rail in place, but it is also an extremely efficient rail anchor, the key being driven in the direction of creep.

The standard 80-lb. chair with standard $\frac{7}{8}$ inch. diameter by $5\frac{3}{4}$ inch. coachscrew is shewn.

Check Chairs on Wooden Sleepers.

Check rails are used extensively for minimising the wear on the rail on the high leg of sharp curves. At Union, various types of check-chairs were in use, and in 1911 an 80-lb. cast steel chair with pressed steel buttress, and a 60-lb. rolled steel chair with pressed steel buttress were designed. In both these types, the rails and buttress were held down by coachscrews.

In 1921 an 80-lb. cast steel chair with a cast steel buttress was designed, the running rail being secured by a spring key, and the buttress held down by coachscrews. In 1926 a 60-lb. cast steel chair with cast steel buttress was designed, the running rail being secured by the standard taper key, and the buttress held down by coachscrews. This design is still the standard for 60-lb. track.

The design for the 80-lb. chair described above was, however, not satisfactory and in 1930 a 96-lb. cast steel chair was designed in which both the running and check rail were held by standard taper keys, and in addition a cast steel buttress was provided bearing on a rib at the back of the chair, and held in position by a T bolt so designed that the buttress could be placed in position after the chair had been fixed to the sleeper. This design has proved very satisfactory (see illustration).

In 1938 an 81-lb. chair was designed on the same principle as the 96-lb. chair.

Check Chairs on Steel Sleepers.

In 1927 the first check-chair for use on steel sleepers was designed. This was for use in 60-lb. track. It consisted of a rolled steel chair with a cast steel buttress. The running rail on the outside was held down by a standard clip and bolt, and the buttress by a bolt, plus a clip and bolt between running and check rail, the bolts all being T bolts through chair and sleeper, and capable of being inserted from the top. In 1931 similar chairs were designed for 80 and 96-lb. track.

In 1938–39 check chairs for 60 and 80-lb. track were designed with the central bolt replaced by two wedge bolts fitting on a central rib on the chair, and a special H clip securing the running and check rails.

All the above designs are still in use but they are not considered quite satisfactory, and experiments are now being carried out with a view to evolving a better design.

Sleepers.

At Union, steel sleepers, wood sleepers and pot sleepers (both cast iron and pressed steel) were in use. The number of pot sleepers was small and they were soon replaced. At present 69 per cent. of the sleepers in use are steel. This type of sleeper is not used at the coast or on electrified sections.

In 1923 the 80-lb. steel sleeper with clip and bolt was designed and this design with slight amendments is the present standard. The bolt is a T-headed bolt capable of insertion from the top. Since then similar designs for other weights of track have been evolved, the 60-lb. in 1924, and the 45 and 35-lb. in 1928.

As mentioned previously the 80-lb. sleeper is also used for 96-lb. track.

With regard to wooden sleepers, the standard sizes are 10 inch by 5 inch by 7 foot 0 inch long for 60-lb. track and heavier, and 9 inch by $4\frac{1}{2}$ inch by 6 foot 6 inch long for 45-lb. tracks. These were also the pre-Union standards.

The only type of concrete sleeper which has been used to any extent is the concrete pot sleeper. It was used as a war-time measure to a limited extent, during the 1914–1918 war, and fairly extensively during the 1939–1945 war, on unimportant loops and sidings.

Points and Crossings.

In the type of points and crossings in use the chair consists of a steel plate out of which a lug

SOUTH AFRICAN RAILWAYS
WITH
ROAD MOTOR SERVICES
BECHUANALAND
PROTECTORATE
Tropic of Capricorn
KALAHARI
DESERT
SOUTH WEST
AFRICA
TRANSVAAL
ORANGE
FREE
STATE
BASUTOLAND
NATAL
SWAZILAND
CAPE OF GOOD HOPE
RHODESIA
MOÇAMBIQUE
ATLANTIC OCEAN
INDIAN OCEAN
Walvis Bay
Gobabis
Luderitz
Keetmanshoop
Karasburg
Orange R.
Port Nolloth
Upington
Prieska
De Aar
Carnarvon
Williston
Bitterfontein
Van Rhynsdorp
Saldanha
CAPE TOWN
Paarl
Stellenbosch
Somerset West
Worcester
Bredasdorp
Beaufort West
Oudtshoorn
George
Mossel Bay
Graaff Reinet
Hutchinson
PORT ELIZABETH
Port Alfred
Grahamstown
EAST LONDON
King Williamstown
Queenstown
Aliwal North
Umtata
Port St. Johns
Kokstad
Port Shepstone
DURBAN
PIETERMARITZBURG
Ladysmith
Harrismith
Bethlehem
Ladybrand
Maseru
Wepener
BLOEMFONTEIN
KIMBERLEY
Kroonstad
Vryburg
Mafeking
Kanye
JOHANNESBURG
Germiston
PRETORIA
Standerton
Vryheid
Mbabane
Barberton
Nelspruit
Pietersburg
Messina
Serowe
Palapye
Mahalapye
Lourenço Marques

is pressed, the lug nests into the web of the rail and is secured thereto by a bolt.

Prior to Union the various Railways used a straight hinged switch but the switch-blade and stock rail were both on the same level and the stock rail was notched out to take the switch-blade. In 1912 the spring curved switch was introduced, but as with the straight hinged switch the stock rail had to be notched out. This notching of the stock rail was a source of weakness, and in 1925 the jockey type of switch was introduced. In this type of switch the base of the blade is ¼ inch higher than the stock rail and rides on the stock rail so that it is unnecessary to notch this rail. The switch was a straight hinged switch, and this is still the standard.

Prior to 1930, it was standard practice to curve the lead wing rail but the present practice is to have a straight crossing.

In 1925, a double slip with internal switches and moveable central frogs was designed and put into use, but it did not prove to be satisfactory, and double slips with fixed central frogs were standard practice for many years. Owing to the relatively more frequent derailments on the 1 in 9 design an improved design for a 1 in 9 with moveable central frogs was recently prepared, but none are yet in use. A further design for a 1 in 7 double slip with outer switches and fixed central frogs has been prepared, and one of these is now in course of manufacture.

Rail Lubricators.

Various methods of lubricating check rails have been used for many years. These were mostly manual methods.

In 1938 experiments were made on lubricating the high leg of curves by means of an automatic machine feeding grease to wheel flanges of passing vehicles. The results of these experiments were highly satisfactory. There is now a large number of such machines in use.

In 1943 a method of lubricating the check rail by means of a similar automatic machine was evolved, and in collaboration with the manufacturers, experimental machines were installed. These machines have proved to be very satisfactory and a large number will shortly be installed.

Manufacture of Permanent Way Material.

All permanent way material was obtained from overseas for many years, but the manufacture of this material in South Africa is gaining ground.

In 1934 the South African Iron and Steel Corporation commenced rolling rails, and at present about 10 per cent. of the requirements are obtained from this source. All the cast iron chairs are made locally and within recent years check-chairs and soleplates have also been made. The locally-made soleplates are, however, either of the cast steel or drop stamped type and the rolled steel type is only obtainable from overseas.

Ballast.

Many of the original lines were laid direct on the formation and merely gravel-ballasted, but since the time of Union all the important lines have been ballasted with hard stone.

In the case of the more important main lines there has been little change since Union in the quantity of ballast per mile. For Class I lines the present standard is 2,200 yards per mile, top width 8 feet 0 inches and 8 inches of ballast under the wooden sleeper, or 12 inches of ballast under the top of the steel sleeper.

Tunnels.

In 1910 there were in existence fourteen tunnels totalling 1¾ miles in length. Two of these were in Natal, ten in the Cape, and two in the Transvaal.

At present, besides the tunnels on the improvements to the main line from East London to Burghersdorp, now under construction, there are 64 tunnels totalling 9½ miles in length. Of these, 24 totalling 5¼ miles are situated on the Natal main line and are distributed over a distance of 300 miles. The present longest

Three-way Fly-over at Langlaagte—near Johannesburg.

tunnel is the twin tunnel at Delville Wood, 3,002 feet in length, which is situated 25 miles from Durban on the improved line from Durban to Cato Ridge.

On the old line from East London to Burghersdorp there were no tunnels but on the new main line there will be twelve tunnels totalling 5,364 yards in length, distributed over a distance of 136 miles. The longest tunnel will be the Hobb's Hill tunnel near Cathcart which will be 3,183 feet long. Of these tunnels one has so far been brought into use.

A scheme for improving the gradients and curvature on the main line from Cape Town to Johannesburg where it crosses the Hex River Mountains has been adopted, and on the proposed route there will be one main tunnel 7¾ miles in length, two half-a-mile in length and one a quarter-of-a-mile in length.

Enlargement of the Loading Gauge.

In 1916 a special vehicle was constructed for the measurement of all fixed structures throughout the Union, and as a result of the survey a revised loading gauge was adopted. It was found, however, that this loading gauge was rather narrow at the top and restricted the design of rolling-stock. In 1930 another survey was made, and as a result the present loading gauge was adopted early in 1939. This loading gauge is applicable to all 3 foot 6 inch gauge lines throughout the Union with the exception of two tunnels, the le Roux tunnel on the Oudtshoorn–Klipplaat section, and the Sir Lowry Pass Tunnel on the Eersterivier–Protem section. Arrangements are now in hand to improve clearances in these tunnels to allow this loading gauge to be applicable to them also.

In dealing with the conveyance of special loads such as stators, transformers and tanks, it was found that a large number of these special loads were outside the standard loading gauge, and in 1930 an abnormal loading gauge was adopted for the main lines from the four principal ports of Cape Town, Port Elizabeth, East London and Durban to Johannesburg.

An endeavour is now being made to achieve a further improvement to the loading gauge, and arrangements are in hand for a survey to be undertaken to investigate the possibility of the adoption of the loading gauge depicted.

Welding Technique.

Long Welded Rails.

In 1934, as the result of experiments, it was decided to weld certain rails into 72 foot lengths by the electric arc-welding process. These arc-welded joints under light traffic and axle-loads stood up fairly well, but so many joints failed after some time in service that certain sections had to be lifted and replaced. This method of welding rails into longer lengths has now been discontinued.

Two flash-butt welding depots have been established, one at Danskraal in Natal, and one at Elandsfontein in the Transvaal.

It was found that a 120-foot long flash-butt welded rail was the longest length that could be transported round 300-foot curves on a 3 foot 6 inch gauge track, and 120 feet was, therefore, adopted as a standard length of rail. Up to March, 1946, some 1,500 miles of track had been rerailed with these 120-foot rails. This mileage of welded rails required the making of some 700,000 welded joints, and, of these, fourteen have failed during the last ten years. At present the monthly average output per flash-butt welding machine per hour is 16 to 17 joints.

Welded joints are tested by applying a load central with the joint until a deflection of 40 millimetres is obtained on a 1-metre span. Three test joints are made every eight hours and should any of these fail, further joints are cut out from rails which have been welded since the last successful test welds were made. In the case of failure of any of these joints, the whole

batch of welded rails is rejected and joints re-welded.

During the war, owing to the difficulty in obtaining new rails, an extensive programme of reconditioning second-hand rails was inaugurated. Approximately 25,000 tons of rails were reconditioned yearly, and after reconditioning were classified, matched, and welded into rails up to 120 feet in length. The reconditioning of these rails consisted of straightening them carefully in both the horizontal and vertical planes, cutting off the ends where the fishing angles were badly worn or the rail-ends badly battered, building up skid marks and cutting out badly-flawed sections. Had it not been for this programme of reconditioning and welding, these railways would have been in a parlous situation, indeed, towards the latter part of the war owing to the dearth of new rails.

Considerable difficulty was experienced in the welding of these second-hand rails because of their variation in chemical analysis. Some rails which were rolled in 1880 were found to have a higher silicon and carbon content than others, and sometimes the phosphorous content was found to be so high that sound welds were quite impossible.

Another step in the development of rail-welding was increasing the length of the rails by Thermit welding a number of 120-foot rails into longer lengths on the site, and a section of track one mile in length was put down with continuous rails as an experiment. The track was of special construction as in addition to the two running rails, two ballast rails were secured underneath the sleepers. The idea of these ballast rails was to obviate the possibility of the track kicking out. No difficulty, however, was experienced in holding the track in alignment for it had been thoroughly centred, packed and ballasted, and maintenance over a period of ten years has proved to be considerably less than for track laid with standard 40-foot long rails.

After it was found that these long rails were practicable, all the rails in the tunnels on the Johannesburg–Durban main line were welded together into continuous lengths of up to approximately 3,000 feet. At the same time 120-foot rails were Thermit-welded into 240-foot lengths, and these were placed in the track on the Natal South Coast line without any special precautions being taken. This was followed by 480-foot long rails in shunting yards and recently by 480-foot long rails in main lines for test purposes.

Within the last few months, however, there have been serious failures of the Thermit-welded joints, and the position at present is that no further welding by the Thermit process is advocated.

The conclusions drawn from experience of welded rails is therefore that—

(*a*) no satisfactory arc-welded joint design and technique have as yet been developed ;

(*b*) flash-butt welded rail joints are eminently satisfactory ;

(*c*) it remains to be proved whether a satisfactory Thermit-welded joint can be produced.

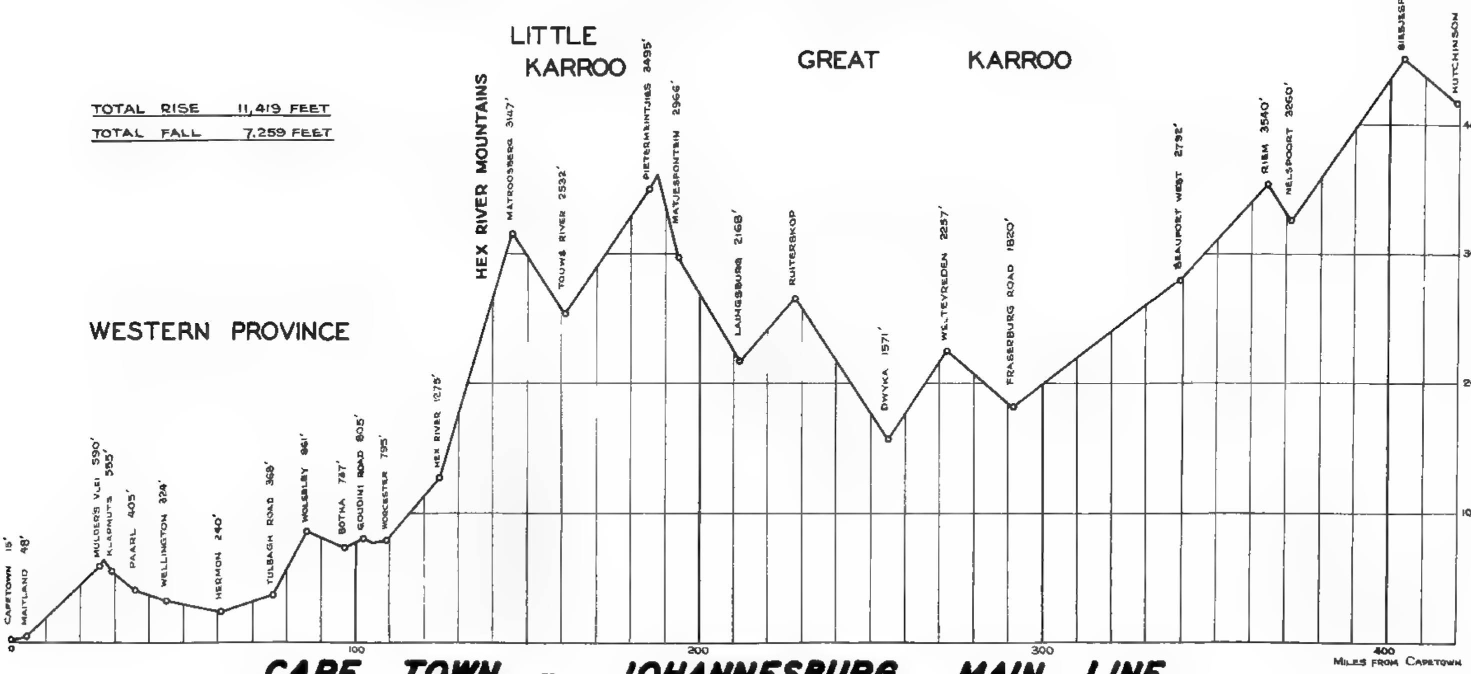
As regards the running qualities of the track laid with 120-foot rails, there can be no controversy ; riding qualities are improved, noise is reduced, and joint maintenance considerably reduced.

Building Up of Battered Rail-Ends.

When the arc-welding of rails into long lengths was started, the battered ends of rails were built up by welding in the track at the same time. When flash-butt welding superseded arc-welding of the rail joints, building-up of the battered rail-ends was not discontinued, however, but gradually extended. So satisfactory have the results been that plant is being provided to permit the formation of nine track-welding gangs, each of which will be capable of reconditioning 100 to 120 miles of track per annum. The plant for this work is now being imported and great advantages and savings are anticipated from this work.

SOUTH AFRICAN RAILWAYS.

SECTION: CAPE TOWN - HUTCHINSON



CAPE TOWN - JOHANNESBURG MAIN LINE

Reclamation of Tools.

A method has been developed for reclaiming worn beaters. At the present moment beaters are being reclaimed in this way at the rate of 80,000 per year. This repair work was of almost inestimable value during the war when track tools were to all intents and purposes practically unobtainable. Recently augers for the drilling of sleepers have also been reclaimed on a fairly large scale by building up the worn ends with "Stellite", and rebuilding and grinding the pilot thread. This has served to tide the South African Railways over a difficult period when new augers were unobtainable.

Crossings have been reconditioned by both the electric and gas-welding processes. Gas-welding only came into its own during the war when grinding equipment became almost unprocurable. Gas-welding has, however, proved very satisfactory as well as economical, especially where crossings have to be repaired in the track. Crossings are now being repaired at the rate of about 550 per month under the control of the Chief Civil Engineer, and about 300 per month under the control of the System Managers.

Developments in Structural Engineering.

An extensive new Mechanical Workshops programme has now been adopted, and for these new shops the pitched type of roof with a double monitor for light and ventilation has been adopted. The present standard dimensions, 70 foot 10 inch centres of crane girders, 75 foot 0 inch centres of main columns, and clearances for overhead cranes have been retained, but the centres of the columns in the longitudinal direction have been altered to 25 foot 0 inch, all the shops being of the longitudinal type. The roof covering will be corrugated asbestos or some form of protected metal sheeting, and the sides will be brickwork.

Bridges.

There are no spectacular bridges on the South African Railways comparable with those to be found in many parts of the world, but the nature of the country is such that very extensive bridging has been necessary.

There are more than 40,000 bridged openings throughout the Union and South-West Africa, and of these approximately 10,000 are regarded as major bridges, the total length of which borders on 400,000 feet.

Round a large part of the coastline, the rise from sea level to mountainous regions is very rapid so that during the seasons of heavy rainfall the many rivers running to the sea become quickly swollen with very fast-flowing flood waters.

The scouring effects on river beds of these high-velocity floods are such as to require the use of deep foundations for all major river bridges within or near the coastal belt. Unless rock is encountered, these foundations (consisting of concrete cylinders or caissons) are usually taken down 80 feet to 90 feet below river-bed, and in some instances they have been taken to as much as 150 feet below river-bed.

The South African rivers are navigable by small craft only and then only for limited distances. This fact obviates the need to provide long and high spans across navigation channels.

In areas outside the coastal belt, steel is generally favoured for the superstructure of major bridges, the spans for which vary from 30 to 150 feet.

The longest steel bridge, 3,514 feet, crosses the Orange River at Upington in South-West Africa, the spans used being a combination of 30-foot, 80-foot and 100-foot. An interesting steel bridge, the only one of its type in the Union, crosses the Buffalo River at East London. It is a double-deck rail and road bridge, the road and footways being carried on the upper deck and the railway on the lower deck. The bridge is about 1,000 feet long, the main river spans being 150 feet and the flanking spans 50 feet. The longest steel span is 230 feet lattice girder, whilst the highest which crosses Van Stadens Gorge in the Cape, has a rail level 250 feet above the river-bed.

Within the coastal belt corrosion of steel structures can be exceptionally rapid, and for this reason a policy was adopted some years ago of constructing all new coastal bridges in reinforced concrete. Amongst the notable concrete bridges may be mentioned the recently completed crossing of the Umhlatuzi River in Zululand. The structure consists of seven 120-foot span tied arches. So far as is known there are only two other reinforced concrete tied arch bridges carrying railways in the world. Another concrete bridge is at present in course of construction across the Umkomaas River on the South Coast of Natal. This is a nine span structure of simply supported tee beams, the piers being at 81-foot centres which is greater than is usually adopted for simply supported reinforced concrete beams carrying a railway. The deck of the bridge will be wide enough to accommodate two tracks and a National Road.

In a country such as South Africa which has a small widely-scattered population, it is natural that when the railways were being developed and when roads were not well defined and little used, many level crossings of road and rail were permitted.

In 1928 it was decided to embark upon a programme of level crossing elimination, and since then the number of level crossings has been reduced by more than 200. The bridges to replace level crossings in or near towns have received special attention. They are practically all built in reinforced concrete.

When the South African Railways succeeded the different railway systems in existence in 1910, the problem of determining just what loading existing bridges could carry became a very complicated one. In 1924 a department was created to re-survey and thereafter calculate and record the strength properties of every bridged opening. This was a large and costly undertaking, but it has been exceedingly useful. The upward trend of locomotive axle-loads has continued and bridge replacement or strengthening has had to keep pace. Many loading standards have, from time to time, been used in the design of bridges but in 1926 after very careful consideration of all factors, it was decided that for the foresee-able future, main line locomotives could not have an axle-load exceeding 22 tons. This is the present-day standard used in the design of main line bridges. One other loading standard only in now used in the design of branch line bridges and in this case the controlling locomotive axle-load is 15 tons.

Civil Engineering Research.

Civil Engineering Research on the South African Railways may be said to have developed with the appointment of a Research Engineer in 1927 for the specific task of investigating the general question of track stresses and permissible axle-loads on track. In the absence of any real research organisation, the Research Engineer was often called upon to act as technical adviser to the Chief Civil Engineer in routine matters that hardly involved research. In the course of time the nucleus of a Research Section was formed under the Research Engineer. The second World War was a considerable setback to this branch, staff being depleted and progressive research disorganised in all but one or two directions.

Despite handicaps from shortage of staff and lack of adequate facilities, a great deal of valuable work has been accomplished over the years. Among the problems which have received attention, the most important are :—

(1) Permissible axle-loads, track stresses, and classification of lines.

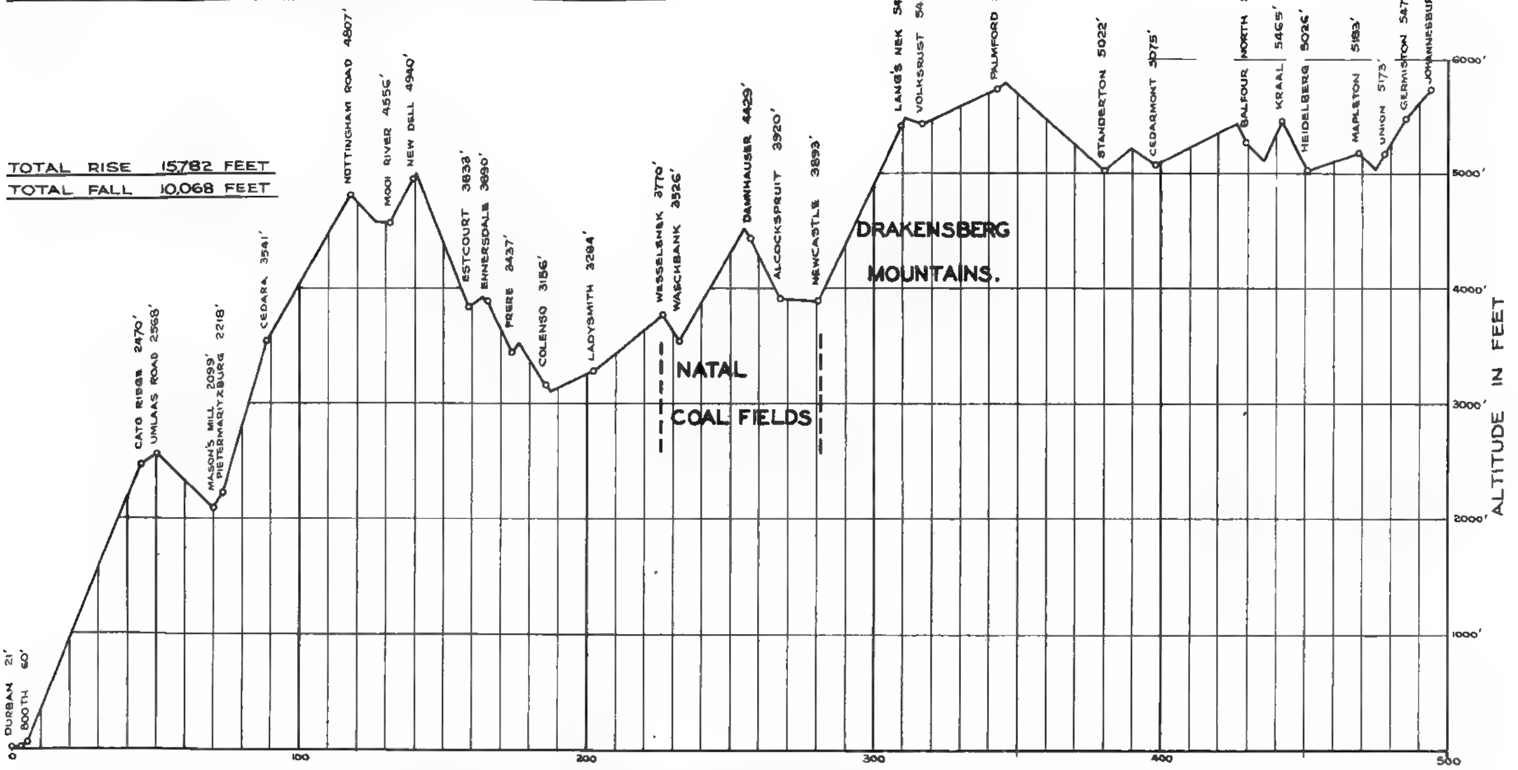
(2) Super-elevation and maximum speeds on curves.

(3) Motion and stability of vehicles against overturning and derailment.

(4) Development of long welded rails and temperature stress problems related thereto.

(5) Economics of deviations and wear of rails in relation to curvature.

SOUTH AFRICAN RAILWAYS.
SMALL SCALE LONGITUDINAL SECTION.



DURBAN TO JOHANNESBURG.

(6) Corrugation of rails.
(7) Impact of railway bridges.

Architectural Work.

Included in the responsibility of the Chief Civil Engineer is the direction of the Architectural branch, which is responsible for station buildings, office blocks, training colleges, police barracks, health and welfare centres, goods sheds, laundries, workshops, recreation clubs and all other buildings. Special attention is now being given to the provision of better lighting, heating, insulation, ventilation, and lavatory facilities.

The old Cape and similar styles of architecture have been used at out-stations where the setting and historical background are suitable, but in the industrial areas a modern functional type of building is preferred. Plans include garden layouts and special facilities for advertising, the object being to prevent unsightliness on the one hand and to improve the appearance of all railway premises on the other.

Station planning in South Africa has to take into account the needs of the non-European races. At Johannesburg a separate non-European station, complete with the usual station offices, restaurants and rest rooms, is proposed, while, in general, stations have special shelters and other features designed for the comfort and convenience of Europeans and Africans. In the interior, cities like Johannesburg and Pretoria ; and along the coast, the ports of Durban, Cape Town, East London and Port Elizabeth have been selected among others. All have experienced accelerated development, due in some measure to the war, but chiefly to be ascribed to the vigorous growth of the Union's economic life. The railway construction programme is virtually dominating the national re-building scene, since it will ultimately involve the expenditure of approximately £180,000,000 on various forms of improvements, but new stations will account for only a fraction of this expenditure.

In design the proposed new stations follow overseas practices to a considerable degree, but there are important variations to meet local conditions. A mixed population is a factor which is being taken into serious account, whilst such considerations as the abatement of smoke nuisance in the larger urban areas and the elimination of noisy shunting have directed general planning policy.

Since fundamentally the new stations and yard layouts contemplated conform to a general pattern, a description of one of the new projects will serve to show the compass of railway planning, and the general aims of South African railway policy. Cape Town, the southern gateway to the Union of South Africa, and one of the most important harbours, is also the south-western terminus of the South African Railways' system and offers a good illustration of new station planning.

Four sets of lines radiate from Cape Town station, although the actual converging point is 2½ miles to the east of it.

All trains working into the new station will be electrified, each of the four routes will have its own " UP " and " DOWN " tracks. Signalling will be three-aspect colour light.

The station will be of the dead-end terminal type having 24 platforms, the ends of which will connect with the concourse at the same level.

Ticket hatches, bookstalls, a tearoom, lounges, a bar, parcels and cloak room conveniences plus telephone and enquiry booths will be conveniently arranged in and around the suburban concourse.

For several years now the Railways have had under consideration a major station-building programme. Officers were sent to North and South America, to the United Kingdom and to various European countries some years ago to study modern methods of station design and management, and these are being incorporated to a large extent in the proposed new stations. The question is an urgent one since in the Union the tendency of the population to concentrate in the larger urban centres is very marked.

Most of the present stations have become inadequate, not only in point of size but also in the facilities available for the handling of passengers and their luggage. Instead of waiting rooms being a delightful introduction to a journey, they are often drab, while the lighting is generally poor. These stations belong to another era, when competition with the Railways in the transport field was either non-existent or too negligible to be taken seriously.

Conditions have changed. The traveller has alternative types of transport at his disposal and the Railways have to equip themselves with selling power of a high order. The station of the future must be able to attract passengers in a positive way; it must be pleasant in appearance and must offer a wide variety of both interest and comfort. Lighting must be good and the Railways must be able to offer travellers some initial advantage in relation to other forms of transport. The railway station can make a substantial contribution towards this end.

With these considerations in mind, the South African Railways are planning to build a number of new stations in the larger centres as well as in some of the more progressive smaller towns.

Marshalling Yards.

The Bellville Marshalling Yard, a new project (see illustration), is an example of the trend of development which has taken place in the planning of marshalling yards since Union. A full description follows. Bellville has been selected merely as an illustration of what is being done. New marshalling yards are being laid out also in other parts of the country.

Bellville, twelve miles east of Cape Town, is the final converging point of the lines from the interior to the Cape Town area. It is the most suitable point to sort mixed train loads of incoming traffic for final destinations and to marshal outgoing traffic into loads for specific routes and into station order for the shorter distances.

In the new plan the converging double lines will retain their " Up " and " Down " identity between Bellville and Cape Town, but the provision of " Up " and " Down " yards on their correct sides of the Main lines is not feasible and in many respects is not desirable.

The yard will be laid out in two parts : " Up " (i.e. towards Cape Town) and " Down " (i.e. to the interior). Both yards will be in series with exchange facilities for whole trucks or for tranships between the two.

"Up" Yard.

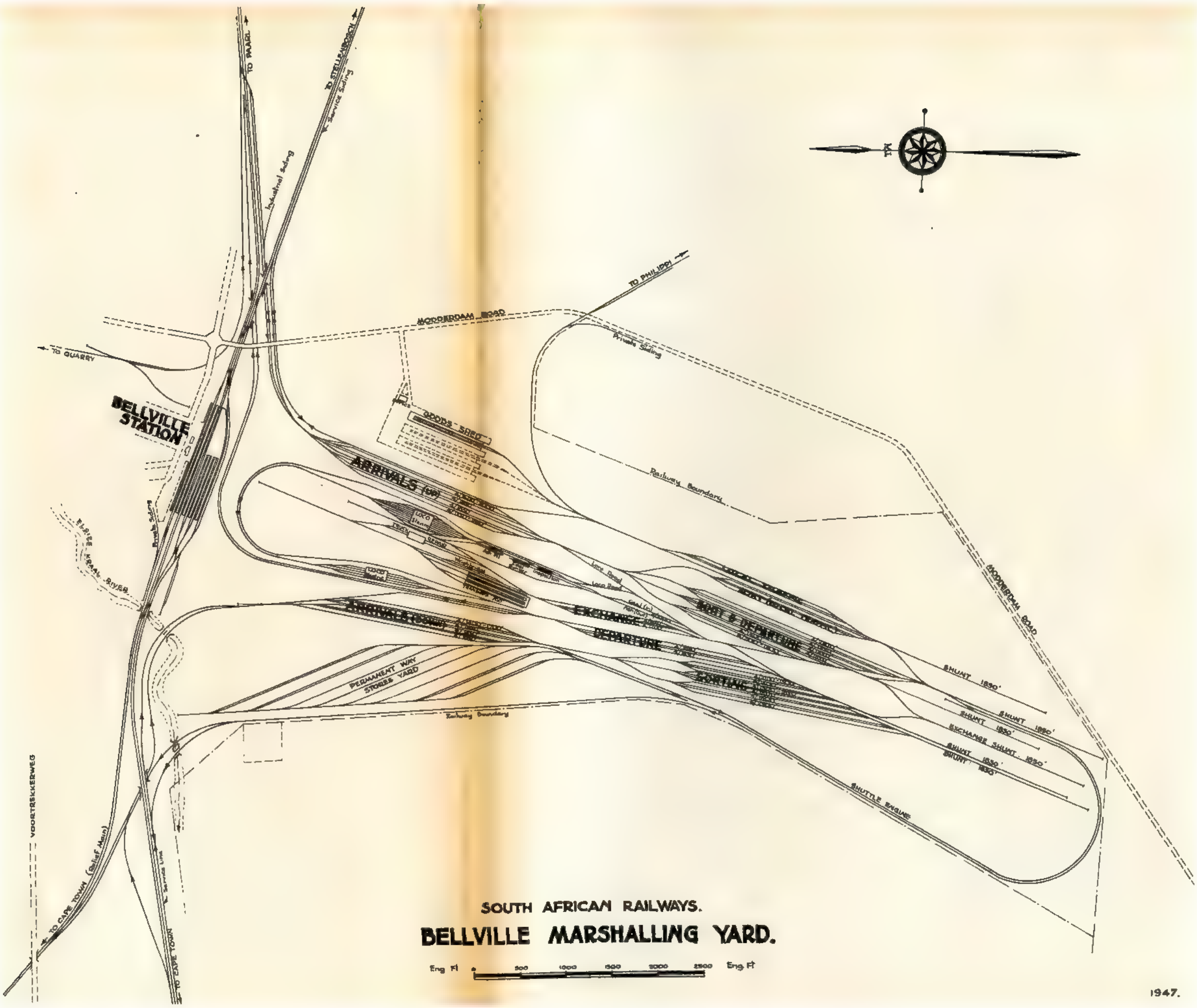
Up trains will be turned out from the " Up " lines, not less than a full train length clear of the " Up " arrival yard and will proceed to it, the train from Paarl running under the Stellenbosch Main Lines ; the engine will be detached to the right, clearing the shunting yard, and then, by means of one reverse, will proceed to loco or direct to attach to a train for " Down " departure. The load will be propelled down grade, in an initial sorting into destination groups, and any further sorting will be accomplished by means of the shunting legs on the opposite end of the sorting yard. Departures from this yard will have a maximum distance of 12 miles to travel and will constitute the return load for shuttle engines to the " Down " arrivals.

Transfers of traffic to the " Down " yard will be achieved via the centrally situated exchange shunt, or through the centrally located exchange yard, into which will be placed all trucks for tranship, weighbridge or repair.

Departure from the " Up " yard will be via the balloon to join the " Up" Main or "Up" Relief Main Lines. The grade separations, and the provision of maximum train lengths between the points of take-off and fouling will prevent interference with proper movement on the Main Lines.

"Down" Yard.

The arrangements for Arrival, Sorting and



SOUTH AFRICAN RAILWAYS.

BELLVILLE MARSHALLING YARD.

Exchange will be exactly similar to those described for the " Up " yards. The engine, in this case on a shuttle service, will detach, depart to the right, proceed to the " Up " yard and await an " Up " load.

The engine (ex loco or recently detached from an " Up " arrival) will be attached to the train which departs to the " Down " Mains. Grade separation will permit direct entry to the " Down " Paarl line. The " Down " Stellenbosch line will be reached over a diamond on the " Up " Stellenbosch line and the train will be held, if necessary, on the adequate length of track available.

The most difficult local traffic from the operating point of view will be that from or to the north side of the line. Its density will not warrant a complete system of grade separations and it will be handled by a single line, crossing the Stellenbosch arrivals, running under the Stellenbosch Mains, crossing the Paarl Main by diamond on to a dead-end shunt and thence reversing. This service will be required only once daily.

Engine Movements.

The movements of Main Line and shuttle engines have been described in the operation of the " Up " and " Down " yards. The siting of the loco and balloon between the " Up " and " Down " yards minimises these movements and allows the shunting engines to proceed between the loco and their working road with little or no interference with other operations. The loco depot will be able to draw its coal and place its ash without interfering with the movements of other traffic.

MECHANICAL DEPARTMENT.

An important part of the creative work necessary to maintain a modern railway system is performed in the mechanical workshops, which in South Africa not only serve as repair depots for worn or damaged locomotives, saloons, rolling-stock and other equipment, but also manufacture new stock. Since the efficiency of the workshops can be directly related to the efficiency of a railway system as a whole, much thought and careful planning have been devoted to the improvement of the comprehensive network of mechanical workshops which serve the South African Railways. At present several new workshops are under construction, designed to measure up to modern conceptions of comfort and convenience for the staff, and all equipped with the latest instruments and tools. At the same time existing shops are being modernised and overhauled.

The Mechanical Department of the South African Railways has had to go far beyond the scope of ordinary repair work. The manufacture in the Union of heavy iron and steel products has for many years been limited by severely restricted demands due in a large measure to the Union's comparatively small population, and the Railways have been forced by conditions to be self-reliant to a degree. Under these circumstances the development of the Mechanical Department has had to keep pace with the expansion of railway operations, and the few, poorly-equipped workshops, which served the early railway companies, have been replaced at strategic centres by a network of well-equipped shops. These are now being modernised and expanded. Repair work is still the main pre-occupation, but manufacture of new stock is being gradually extended. At the same time the heavy steel industry in the Union is developing and private enterprise has entered the manufacturing field to a significant degree. Large orders for goods wagons are now being executed by commercial firms in the Union, at prices competitive with the imported article.

The South African Railways have for years been manufacturing coaches and goods vehicles, but only on a limited scale. All wheels, axles and tyres are imported, but the South African market can now supply steel, iron and brass castings ; steel chains ; buffalo hides ; enamels and paints ; copper bar ; articles in rubber for vacuum brake and steam heating gear ; steel wire ropes and many other articles. The locomotives in use were nearly all built overseas

to the specifications and designs of the Chief Mechanical Engineers of the South African Railways.

The powerful engine harnessed to an express train may stir the romantic heart of the public and may bring to the imagination visions of distant places and of remote corners of the country, but it is the railway workshop, often untidy, always drab and unpicturesque, which makes railway operation possible. It follows that since the inception of railways in South Africa the erection of workshops has always received special attention, and direct encouragement has been given to the development of the necessary labour force of artisans and semi-skilled and unskilled workers.

Workshops in the Early Days.

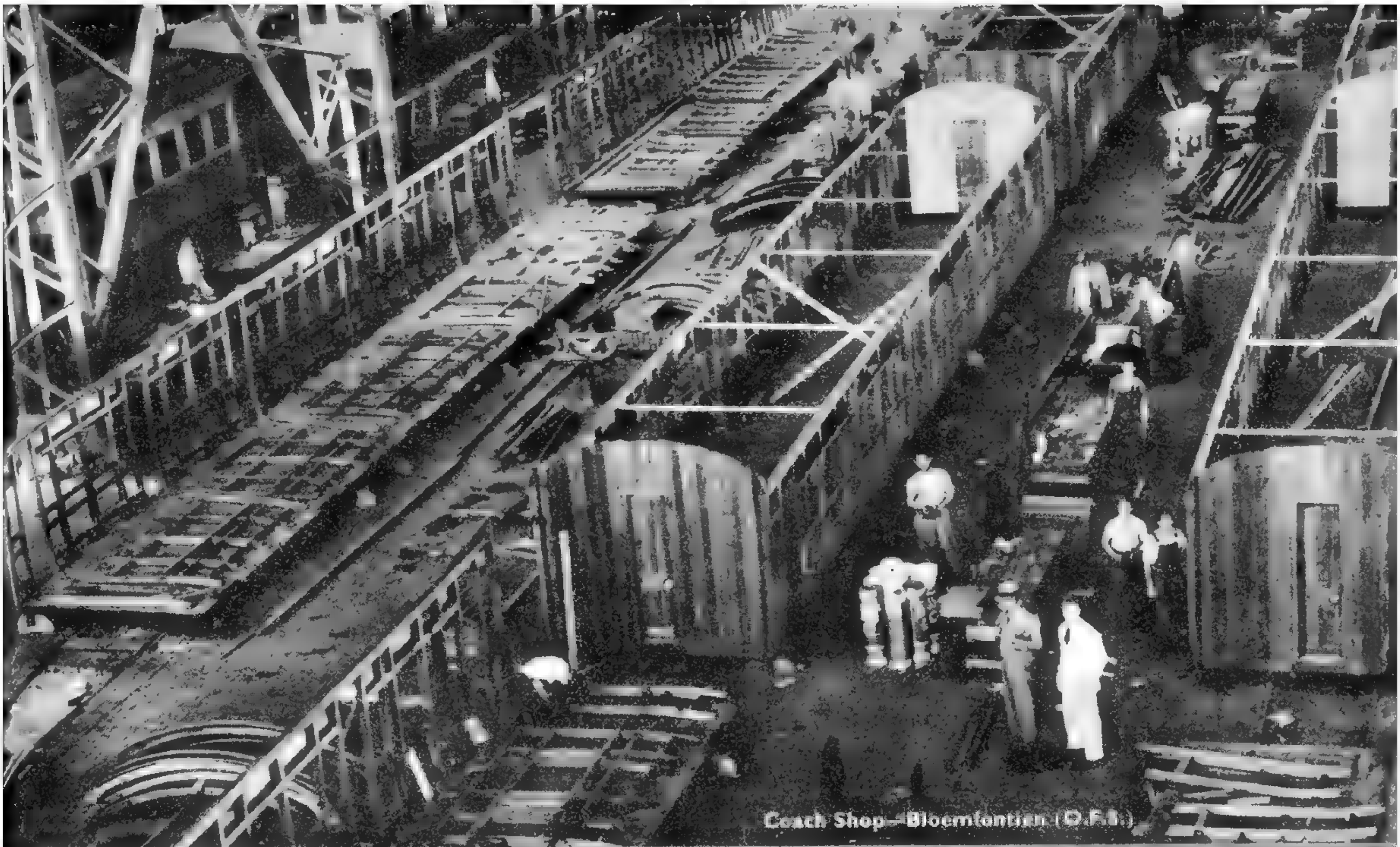
When the first railways were established in the Cape of Good Hope and in Natal small workshops were provided at Cape Town and Durban, followed a few years later, as the railway system expanded, by similar shops at East London and Uitenhage. By 1900 several repair shops had been permanently established to serve railways in the Cape Province and Natal. The Transvaal and the Orange Free State made provision for their own needs by building workshops at Pretoria and Bloemfontein. The development of the Port of Durban, and coal-mining in Natal, led to the erection of a large repair depot at Pietermaritzburg, first as a branch of Durban and ultimately as a separate centre. Here attention was concentrated mainly on repair to goods vehicles.

This was the position in 1910 when the four railway systems in existence in South Africa were amalgamated at Union into the South African Railways and Harbours Administration. The new organisation inherited a large variety of locomotives and rolling-stock. In the early days engines, trucks and saloons were imitations of European designs, adapted to South Africa's 3 foot 6 inch gauge system, but shortly before Union there were definite signs of independent design to meet South African conditions. After Union this tendency developed rapidly.

The locomotives were mostly small units capable of hauling only limited loads at speeds well below 25 miles per hour on the gradients, although there were one or two heavy engines weighing 120 tons on the Natal Government and Central South African Railways. The passenger vehicles were generally short, non-corridor coaches, while the goods stock was made up of short four-wheeled wagons. The workshops were maintenance depots rather than shops, combining construction with maintenance—as is the position to-day. And so the newly-formed mechanical department found itself confronted with the immediate task of obtaining standardisation in design, of designing more powerful locomotives to haul heavy through-loads, and of reorganising the workshops to meet the demands of the wider field.

Distribution of Workshops.

The workshops, except the running sheds at transportation depots, are controlled by the Chief Mechanical Engineer, with a mechanical engineer supervising each. They are located at Salt River, Uitenhage, East London, Bloemfontein, Durban, Pietermaritzburg, Germiston and Pretoria, which provides a Union-wide distribution. All the workshops serve their immediate area for the repair of locomotives and rolling-stock: Germiston specialises in wagon repairs and construction of new wagons. It is not the policy of the Administration to undertake the manufacture of parts where these can be supplied by local industry, but in view of the specialised nature of requirements it has been found necessary to equip the workshops to undertake the manufacture of a number of parts required for the repair and construction of rolling-stock. The South African Railways have for many years built coaches and goods wagons. Preparations are in hand for the production of locomotives and a start has been made with the construction of the S. 1 class



Coach Shop—Bloemfontien (O.F.S.)

Erecting Shop, Salt River, Cape Town

shunting type of locomotive at Salt River workshops.

The functions of the Mechanical Department may be summarised as follows :—

(1) Heavy, intermediate and light repairs to locomotives, tenders and boilers.
(2) Heavy and light repairs to coaches, wagons and travelling cranes.
(3) Maintenance and repair of wharf cranes, harbour plant and floating craft.
(4) Manufacture of parts for engines and rolling-stock.
(5) Building of new rolling-stock, including the manufacture of component parts.
(6) Repair and manufacturing work, including points and crossings and signals and other equipment for other departments of the Administration.

During the recent war a considerable part of the productive capacity of the workshops was diverted to the manufacture of munitions, while ship repair work was undertaken on a major scale.

After Union the workshops were reorganised, and attention was concentrated on designing new types of locomotives to haul the ever-increasing traffic in greater loads and at higher speeds. Heavy gradients and restricting curvatures, as well as light-weight tracks, even on main lines, were some of the immediate problems. To-day the South African Railways operate the largest 3 foot 6 inch gauge system in the world, and some of the engines in use—such as the 23 class, the 15F, the G.M. and the G.E.A.—represent more than thirty years of uninterrupted improvement, not only in design, but also in tractive effort, in speed and in general performance.

Coaching Stock.

The normal type of coaching stock used on the South African Railways is constructed with wooden bodies. Experience over a lengthy period has shown that the timber in the imported coach does not always stand up to the changeable climatic conditions encountered in the runs from the humid coastal area to the hot and dry inland plateau. It has, therefore, been the policy to use locally constructed coaches, in which the wooden bodies are superimposed on steel underframes. These have proved eminently satisfactory and have measured up to requirements to such good effect that during the war period it was found possible to keep them in service long after their theoretical life had expired.

Different standard passenger coaches are provided to meet the needs of the three different passenger groups, the long-distance night traveller, the medium-distance day traveller and the suburban passengers. Each of these groups is divided into three classes of travel, first, second and third. Sleeping accommodation is provided as standard on *all* overnight journeys in all classes. Over and above these, there are special types of coaches which include kitchen and dining cars, observation saloons, travelling post office vans and, during the war, a number of ward coaches for use on hospital trains. The South African Railways also have "de luxe" type air-conditioned coaches for use on certain express trains, on which the comfort is equal to any found in the world. This is the type used on the Royal train during Their Majesties' tour of the Union.

Segregated coaches or compartments of the same standard are provided for non-European travellers in all classes—except the third class which is solely used by Natives and other non-Europeans.

The Administration has standardised on a length of 63 feet for main line coaches—a a possible increase to 65 feet is now being considered—as compared with the pre-Union length of 36 feet and, despite the narrow gauge of 3 foot 6 inches, the width is 9 foot 3 inches which equals the width of coaches used on the broader gauge of other railways. The latest standard design of bogies has a wheelbase of 6 foot 6 inches and roller bearings. The long-distance coaches are divided into compartments and half-compartments (coupes), which are

[illegible] Electric Unit for main line traffic. 2,500 H.P. [illegible]

fitted with seats which at night-time are converted into beds with inner-spring mattresses. The backs of the seats are hinged and can be raised to provide upper bunks. Folding tables and wash-basins add to the comfort of compartments, which in the winter are warmed by radiators, steam-heated from the locomotive. Coaches used for tourist trains are fitted with showers and have a supply of hot and cold water provided from boilers built in the coaches.

The South African traveller, whether in the luxurious " de luxe " class, the middle-class or the poorer class, enjoys a comfort of travel that, in its class, compares with anything railways in other parts of the world can offer.

Goods Stock.

In comparing goods stock in use at Union with the latest acquisitions, the development of special types of rolling-stock to meet the needs of agriculture and industry is thrown into sharp relief. For agriculture there are grain, fruit, dairy, meat and refrigerated wagons as well as cattle wagons, which also serve as covered vehicles for general merchandise ; there are many tank wagons for the conveyance of ammonia, tar, acids, petrol, paraffin and treacle in bulk ; the steel industry has been provided with iron ore hopper-wagons as well as coal-hoppers, and for other industries the Railways provide well-wagons and drop-sided and high-sided trucks, while there are special trucks for explosives. The comparison also reflects the widespread progress made in the provision of 8-wheeled vehicles, with high-carrying capacity, which to-day represent 42 per cent. of the merchandise-carrying vehicles of these railways. Standard bogie coal-wagons have a capacity of 50 tons, although there are a few with a capacity of 70 tons.

All goods vehicles are equipped with vacuum type brakes as well as hand brakes. In regard to couplers the policy is to standardise on the automatic type of single central-buffer coupler. The Bell type buffers are being replaced in accordance with a set programme. After experimentation and observation in service, standardisation of underframes has been fixed at :—

	Covered Bogie Wagons.	*Four-Wheeled Wagons.*
Length over headstocks.......	40 feet.	22 feet.
Width over headstocks........	8 feet.	8 feet.
Distance between bogie centres	27 feet.	—
Distance between wheel centres	6 ft. 1 in.	14 feet.

To provide an adequate number of steel wagons has been a constant problem. As traffic grew under the impetus of expanding industry, mining and agriculture, more and more wagons of greater capacity were needed, but until a comparatively short time ago there was no source of steel supply in the country. Wagons had, therefore, to be imported from Europe and America and erected on arrival, or had to be manufactured from imported steel. With the development of a South African Iron and Steel industry most of the steel now used is produced in the Union.

Locomotives.

South African engineers, limited to the 3 foot 6 inch gauge, had no precedent in other parts of the world to serve as a guide in designing large type locomotives for this gauge. In every class of engine designed, therefore, ideas based on experience in this country have been incorporated. In the course of years engines specially adapted to South African conditions have been developed, until to-day the South African Railways operate some of the heaviest engines for the weight of track.

With few exceptions the locomotives of 1910 were small and slow, their size being limited by the restricted financial resources of the railways ; the track restrictions of lightly-built bridges and culverts, and sharp curves and gradients. Improvements in designs had, to a large extent, to wait upon track improvements before it was possible to introduce large engines capable of hauling heavy loads at greater speeds. Some excellent work was done by the early

designers who showed great ingenuity and resourcefulness in producing engines which, in their day, were considered masterpieces of machinery in comparison with those of the past.

An important contribution to locomotive development has been the standardisation of boilers and engine parts, thereby reducing considerably the time taken for engine repairs. After the unification of the Railways there were eighty-eight different types of locomotives in service, for which some fifty different types of boilers were required, but it has now been found possible to standardise—as far as non-articulated locomotives are concerned—to seven types of boilers, each of which is interchangeable on several types of locomotives. The following are the general specifications of these boilers which are being produced in the Administration's workshops :—

Boiler Type.	Internal Diameter First Course.	Distance Between Tubes Plates.	Heating Surface.			Grate Area.
			Firebox.	Tubes.	Superheater.	
	Ft. In.	Ft. In.	Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.
1	5 0	17 9	123	1,497	366	36
1A	5 0	20 2	123	1,700	404	36
2	5 7½	19 4	142	1,933	492	37
2A	5 7½	21 8	142	2,171	537	37
2B	5 7½	18 4	142	1,836	472	37
3A	6 2¼	19 0½	206	2,682	592	63
3B	6 2¼	22 6	206	3,168	676	63

Standardisation of steam chests, piston valves, liners, motion parts, and boiler mountings have still further reduced the quantity of spare parts to be carried in the workshops and stores.

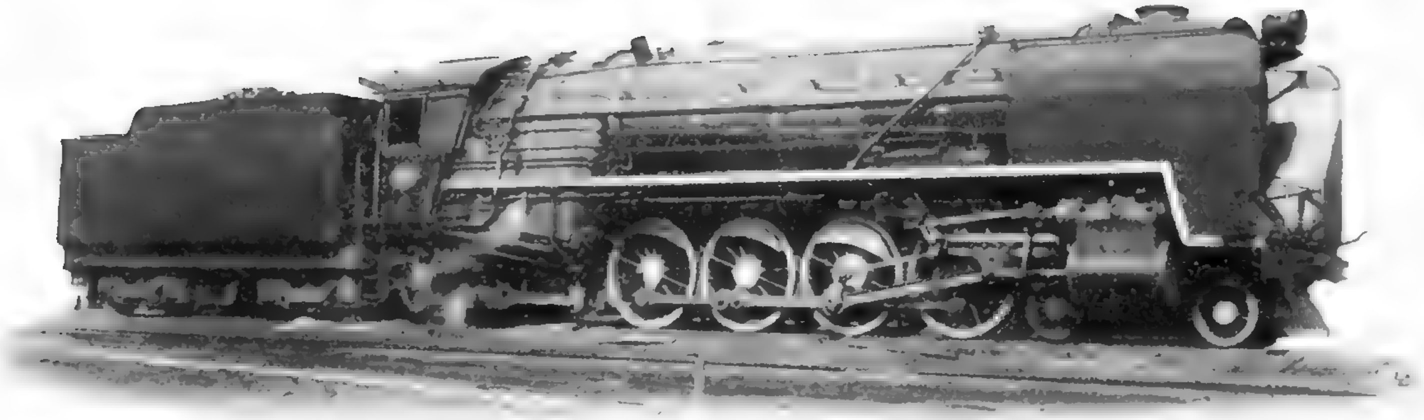
With its large network of feeder and development lines the South African Railways has four main classes of track, and it has been necessary to introduce utility type engines to operate within the following track restrictions :—

Weight of Rail, per Yard.	Maximum Permissible Axle-load in Pounds.
lb.	
45	22,400 to 24,640.
60	29,120 to 33,600.
80	40,320 to 42,560.
96	48,280.

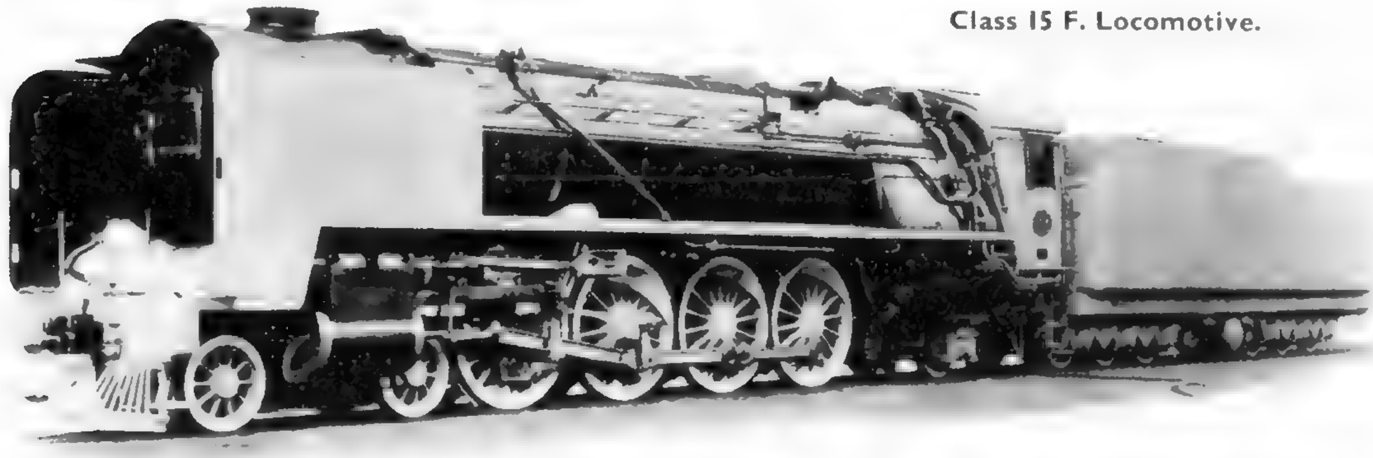
Several types of locomotives are now standardised and these types represent the maximum weight and power which can be developed with 8-coupled wheels, taking into account reliability, trackworthiness, initial outlay and maintenance costs. They are all designed for general utility and are suitable for passenger or goods working. These are :—

Weight of Rail per Yard.	Engine Class.	Wheel Arrangement.	Tractive Effort.
lb.			lb.
45	24	2–8–4	27,600.
60	19D	4–8–2	31,850.
	GM.	4–8–2+2–8–4	60,700.
	GEA.	4–8–2+2–8–4	55,620.
80 / 96	15F.	4–8–2	42,340.
	23	4–8–2	43,200.

In the early days a 3 foot 6 inches gauge was considered in most parts of the world to be equivalent to a branch line and South Africa had to rely on itself almost exclusively for the



Class 15 F. Locomotive.



Class 23 Locomotive

CLASS 15F.

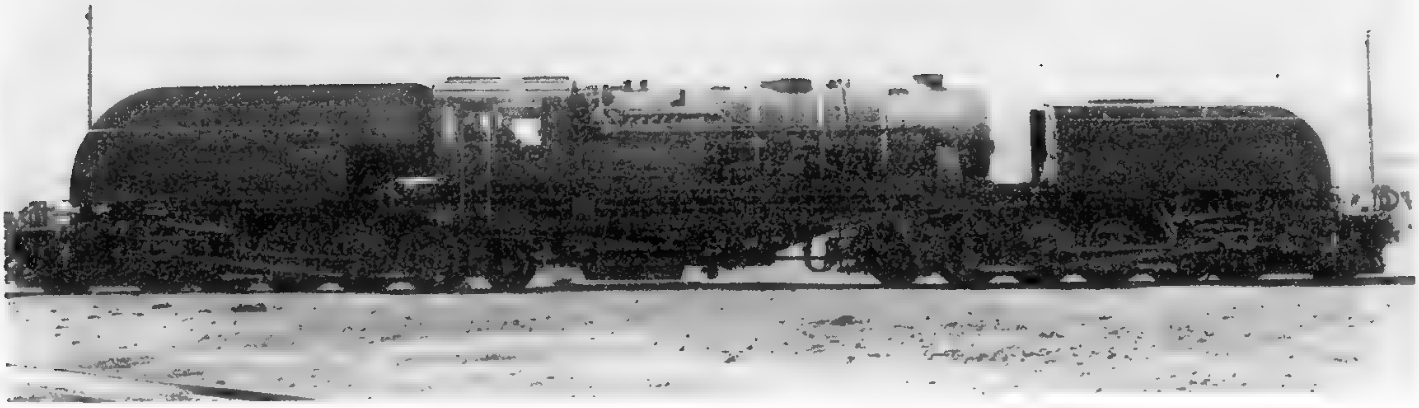
The class 15F locomotive, 4–8–2 type, is very similar to the class 23, and most parts are interchangeable. The diameter of the coupled wheels is 5 ft. 0 in. The diameters of the leading and trailing wheels are 2 ft. 6 in. and 2 ft. 10 in. respectively. The tractive effort at 75 per cent. boiler pressure is 42,340 lb. The total weight of the engine and tender in full working order is 178 tons. The tender is carried on two four-wheeled bogies. The water capacity is 6,000 gallons and coal capacity, 14 tons.

Since 1944, new orders of the class 15F engines have been fitted with vacuum brakes instead of the usual steam brakes. Two vacuum cylinders 24 inch diameter are fitted outside under the running plates on either side at a point midway between the second and third pair of drivers.

There were 155 class 15F engines in service in 1946. An additional 100 class 15F are on order. All the latest engines on the S.A.R. are fitted with a simple layout of controls and fittings in the cab. With the steam turret arranged outside heat in the cab is kept to a minimum. The vacuum and pressure gauges and speed indicator dials are well placed, so as to be in the driver's view without distracting his attention from the road.

The usual arrangement of Stones electric lighting is provided ; this includes 150 Watt Tonum E headlight, a fitting to illuminate the whole of the back of the firebox, and also a light over the reverser control and a bunker light.

The coupler and drawgear at the back of the tender comprise an Alliance central automatic coupler with 8 in. by 6 in. shank with standard yoke.



Class G.E.A.
Locomotive

CLASS GEA.

To meet the ever increasing growth of traffic on branch lines, locomotives with a higher tractive effort were found necessary. The class GEA was placed in service during 1945. The tractive effort is 55,650 lb. at 75 per cent. boiler pressure.

The inner firebox is of steel and the boiler pressure 200 lb. The wheel arrangement is 4–8–2 + 2–8–4 and the coupled wheels 4 ft. 0 in. diameter. Bar frames are 4 in. thick. The rigid wheelbase is 13 ft. 4½ in.

The boiler diameter at the smokebox tubeplate is 7 ft. 0 in. The firebox is fitted with S.A.R. standard type roof stays with two rows of flexible stays at the front end. The Melesco type multiple valve regulator is fitted with 36–1½ in. dia. elements. There are 36 flue tubes, 5½ in. dia. The total heating surface of the boiler is 2,540 sq. ft.; the superheater area 470 sq. ft. and the grate area 51·3 sq. ft.

The four cylinders 19½ in. diameter by 26 in. stroke are arranged with 10 in. dia. piston valves. Walschaert gear is employed. The valve travel of 6½ inches is obtained in full gear, with a maximum cut-off of 75 per cent.

The cab arrangements are made specially convenient for the engine crew. The lubrication is provided by two four-feed Wakefield Eureka type II sight feed lubricators with transfer fillers, each supplying one feed to the steam pipe at the ball joint, one to each cylinder barrel and one feed split between steam chests.

Two 21 inch dia. vacuum cylinders are provided on the front engine with steam and hand brake on the hind engine. Control is effected by a Gresham and Craven 25/20 " SJ " combination ejector with automatic steam brake valve. Stones electric lighting equipment is provided.

The slightly curved shape outer ends of the tanks give an enhanced appearance to the locomotive. The arrangements of piping and shut off valves have been included at both ends of the engine so that at any time feed water can be taken from an auxiliary water tank, when occasion arises.

The total weight of the class GEA in full working order is 184½ tons. There will be 50 class GEA engines in service.

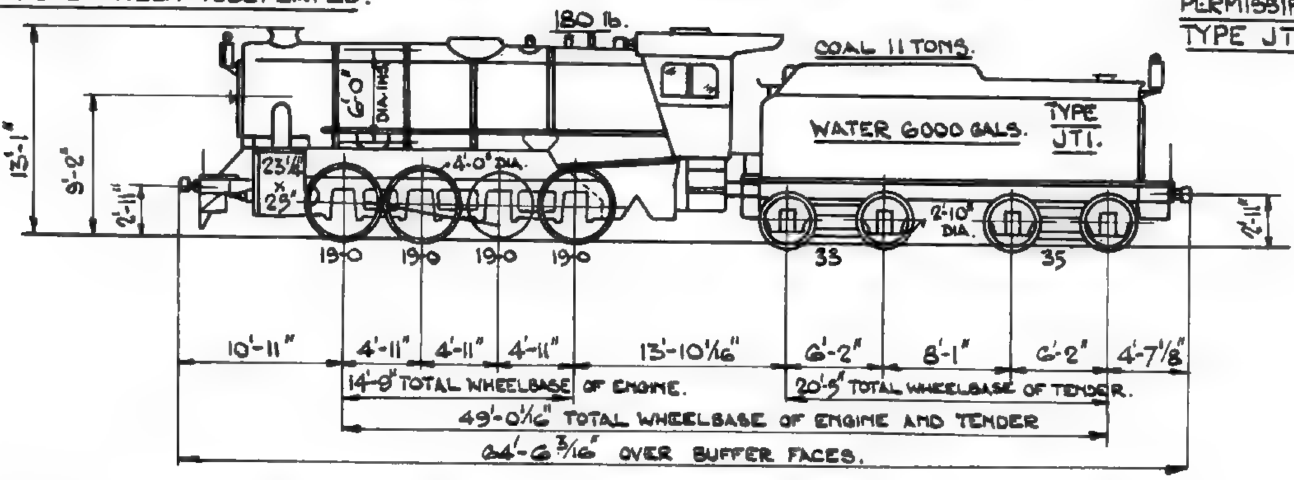
HEATING SURFACE TUBES	1652	SQ FT.
" " ARCH "	20	" "
" " FIREBOX	168	" "
TOTAL	1840	" "
SUPERHEATER AREA	428	" "
FIREGRATE AREA	42	" "

136 TUBES 2" EXT. DIA. 30 TUBES 5½" EXT. DIA.
13'-2 11/16" BETWEEN TUBEPLATES.

TRACTIVE FORCE (75%) 38,000 lbs.
DATE IN SERVICE :- 1947
ENGINE Nos. REFER INDEX ITEM 7.

TOTAL WEIGHT OF ENGINE EMPTY 161,280 lbs.
VALVE GEAR :- WALSCHAERT
DRAWING SERIAL No L-9999.

PERMISSIBLE TENDERS
TYPE JT1.



TOTAL WEIGHT OF ENGINE 76 TONS – CWT. TOTAL WEIGHT OF TENDER 68 TONS – CWT WORKING ORDER.

CLASS S.1. 0-8-0 TYPE. LOCOMOTIVE ; DESIGNED AND BUILT IN THE S.A.R. WORKSHOPS.
PLACED IN SERVICE 1947.

SOUTH AFRICAN BUILT SHUNTING ENGINES.

Twelve heavy shunting engines of the " S " type, complete with tenders, are being built in railway workshops in the Union.

Larger boilers will be installed to permit of an increase in the tractive effort. This will also increase the adhesive weight. These boilers incorporate all the latest features in S.A.R. standard boiler design.

The engine design, generally, has been modified to incorporate all the latest developments. The 0–8–0 wheel arrangement has been adopted, as it is desirable in a shunting engine to have as large a proportion of the engine weight as possible carried on the coupled axles to obtain the maximum adhesion, and because guiding bogies are not required owing to the low speeds used in shunting work.

The boiler will operate at a working pressure of 180 lb. per sq. in. The cylinders are 21½ in. in diameter with a stroke of 25 in. and the coupled wheels are 4 ft. in diameter, giving a tractive force of 38,000 lb. at 75 per cent. full boiler pressure. The engines have been designed for a maximum axleload of 20 tons and can operate over curves with a minimum radius of 165 ft. The tenders have been designed to carry 6,000 gallons of water and 12 tons of coal, and the bunkers have been arranged to permit of the maximum possible field of view to the rear from the driver's seat.

solution of the problems presented by terrain and other factors. The minimum curvature on the South African Railways at present is 300 feet radius and all specifications require an engine to pass a test curve of 275 feet radius. Further limitations on design are the moving structure gauge and the fact that the greater part of the system is laid with single track.

ELECTRICAL DEPARTMENT.

Electric traction was introduced in South Africa in 1925, on a 73-mile stretch of the Natal main line, and since then expansion has been rapid. At present electric train services in South Africa are operated over 581 route miles, while a further 322 miles are under construction.

In the Province of Natal the steep gradients which have to be negotiated (see illustration) give electric traction certain definite advantages. Many heavy freight and passenger trains have to be brought from Durban over several ranges of mountains to the interior, and particularly to Natal's main distribution area, the Witwatersrand goldfields. Johannesburg is 494 miles from Durban and fast running times have to be maintained to meet public demands.

The train services electrified on this system are exclusively main line, and are operated over a route mileage of 405, with a further 55 miles under construction. Four-axle 1,200 H.P. electric locomotives are used. They are operated in multiples, up to three units being controlled by one driver. More than 12,000,000 train miles are run annually in Natal by electric traction, the ton-mileage figure being 6,526,000,000.

In the Cape Province electric working is confined to Cape Town and its environs where suburban services are operated over 45 route miles. The longest electrified stretch is 27 miles, from Cape Town to Simonstown, and multiple-unit motor-coach trains are employed. Cape Town station is one of the busiest in the Union, being second only to Johannesburg. In 1946 passenger journeys on the Cape suburban services totalled 77,754,300, and train mileage, 2,387,900.

Sanction has now been given for the electrification of 195 miles of main line in the Cape Province—from Bellville, the most northern point of the present suburban services, to Touws River. The line winds up and down the precipitous passes of the famous Hex River Mountains, the most formidable barrier between the Cape coastal belt and the interior, and electrification will result in more favourable working conditions. The present line is still as originally surveyed and constructed, as described in Chapter 1, page 27, and it is interesting to note that in a further attempt to improve this section several tunnels are being built. The main tunnel will be eight miles long, through the Matroosberg. The grade and curvature of the present line will be greatly improved since saving in curvature will equal the elimination of thirteen complete circles, while rise and fall will be reduced by approximately 475 feet. The total cost of the work is estimated at £1,078,500, of which £620,000 will be the cost of the main tunnel. Work on the project has started.

The present working voltage of the Cape suburban system is 1,500 D.C., but this is now in the process of being changed to 3,000 D.C., to bring the Cape into line with the Transvaal and Natal. Eventually all passenger and goods trains will be worked electrically to Touws River.

On the Witwatersrand, the main axis of the Union's gold-mining industry, inter-urban services between the various Reef towns were the first to be electrified. Pretoria, the Administrative Capital, was later included in the network. These services are worked by multiple-unit motor-coach trains. The annual train mileage is 3,920,000, while passenger journeys increased from 25,600,000 in 1936 to 84,000,000 in 1946.

All trains in the Reef area can now be worked electrically, and a further programme of extensions to and development of the electrified

sections in the Transvaal has been authorised, involving an expenditure of more than £3,500,000 on track work and £5,500,000 on new locomotives, motor coaches and electric trailers. The intention is to work all trains within the industrial area of the Witwatersrand, Pretoria and Vereeniging with electric traction, and electrification is being extended to Welverdiend on the main line to the Cape and to Vereeniging on the Vaal River.

Train Control.

A train tablet apparatus for single line working, invented by an officer of the Electrical Department and developed by the South African Railways, has successfully helped to overcome the number of instrument failures due to extraneous currents and represents a considerable advance in train control. This instrument, known as the Van Schoor Tablet, is manufactured by the Railways and provides for all phases of single line working.

Air Conditioning.

Air-conditioned vehicles in operation include sleeping, lounge, dining and kitchen cars. These are used on the express trains between Johannesburg and Cape Town, Johannesburg and Durban and on the White Train provided for Their Majesties.

Radio Telephony.

The most significant development in the use of electric power on the South African Railways in recent years has taken place in the field of radio telephony. Experiments designed to establish direct communication with trains in motion have been in progress since 1940, and a solution of the many technical problems involved appears to be in sight. Tests conducted in the Cape and the Transvaal have resulted in messages being successfully exchanged between trains and depots up to forty miles apart.

The results of these experiments were applied with success to the trains used for the Royal Tour. Both the White Train and the Pilot Train were equipped with a central receiving station, and the programmes of the South African Broadcasting Corporation were distributed to approximately sixty loudspeakers on each train. Both the scope and the success of this service far exceeded anything attempted in the past.

The Royal Trains were the first in the Union to be completely equipped with radio communication with the outside world. In addition to the broadcast system, they were fitted with direct telephonic communication with the various railway headquarters. The entire equipment, and the design on which the scheme was based, were drawn up by the electrical engineers as a security measure and also to enable the operating branch to obtain immediate contact with the trains. Although installed primarily for railway purposes and to provide a channel which would enable the Royal Party and entourage to communicate with the outside world, the equipment was made available to the Post Office authorities when the requirements of the Railways had been met and proved of great value in the transmission of press reports.

Radio Beacons.

Important advances have been made in the provision of radio beacons and navigational lights, which are controlled by the Railways. There are twenty-four major lights, virtually all of which have been electrified, and four new beacons came into operation at the beginning of the year. There are now nine of these beacons in service, and there will eventually be twenty-six, spaced at hundred-mile intervals from one end of the South African coastline to the other. Ships fitted with the necessary radio equipment will then be able to take a three-point bearing from any position along the coast.

The beacons emit half-hour signals which have a range of 100 miles, and although out of sight of land ships can plot their positions from these signals with greater accuracy than ever before.

The Department is also keeping in close touch with overseas developments in the use of the centrimetric beam, or as it is more

popularly known, the radio lighthouse, and other navigational aids.

Langlaagte Electrical Workshops.

The war and the shortages it produced promoted far-reaching developments in the manufacturing field, and a great deal of electrical equipment which had formerly been imported from overseas has since then been made for the Railway Administration in its own workshops. To meet war emergencies a special workshop was built at Langlaagte, on the outskirts of Johannesburg, and technicians from all over the country were concentrated there to produce thousands of parts, and in many cases the finished articles, urgently required by the armed forces and the internal railway services. That the South African Railways were able to answer the transportation needs of the country throughout the crisis was due in a large measure to the ingenuity and versatility of the men in these workshops.

Their contribution to the South African war effort was especially important, and a great deal of indispensable equipment was turned out by them. Hundreds of clinometers, dial sights, gun directors, goniometers, and other instruments were produced at Langlaagte during the war years.

The South African Railways operate a telephone and telegraph system, which is independent of the Union post office, and radio stations to provide a supplementary method of communication have been established by the Railways at important centres.

The Electrical Department is directed by the Chief Electrical Engineer, who is responsible also for communication and electric train control instruments.

SIGNALLING PRACTICES.

Uniform signalling practice applies on the South African Railways. Shortly after 1910 signalling officers of the three pre-Union systems spent months in co-ordinating signalling practices and successfully laid a foundation for development and expansion.

The signalling standards provide for many types of signals such as Home, Intermediate Home, Distant, Starter, Advance Starter, Goods, Calling-on and Wrong Road signals, similar to those in use in English practice. An Outer-Home signal with a pointed arm is also provided for in the standards. In the danger position it may be passed after the train has been brought to a stop provided always that the line ahead to the next signal is unoccupied.

All semaphore signals are of the two position type operating in the upper left-hand quadrant, the proceed indication being given by the arm when inclined at 45 degrees to 60 degrees to the horizontal.

The distant signal exhibits a green (proceed) or yellow (caution) light at night, while others show green (proceed) or red (stop) lights. The calling-on signal exhibits no light in the danger position and a small green light when at proceed, whilst the wrong-road proceed indication is given by a small purple light.

Several arm designs have been tried out and the present type is of corrugated sheet steel, 16 Standard Wire Gauge, to which is bolted a cast-iron spectacle frame. All arms are painted red on the front with a white stripe, vee or fishtail according to the class of signal, and white on the back with a black stripe. vee or fishtail.

Dwarf signals consisting of small semaphore arms on low posts are used for controlling shunting movements from sidings to running lines and from running lines to other running lines. The night aspects are red or green. Where interlocked derails are used, a ground indicator of the disc signal type is provided and at night, in the proceed position, exhibits a yellow light.

The wheel type of lever frame which operates points and signals by wire has been found suitable for single line crossing stations and was adopted as a standard, but at certain stations, where working of the points by rodding was more suitable, an English type of lever frame

with duplex interlocking tappets was adopted. Both types of frame have catch-handle locking.

Modifications have been made to the frames and many parts are now interchangeable, while the number of varieties of locking trays has been reduced from 67 to 12.

The double-wire working of points and signals was adopted as standard practice, but has not been retained for signals except where these are at a great distance from the lever frame and where difficulty is experienced in detecting a number of facing points. The actual points-operating gear as adopted in 1910 has been modified in detail only. All wires, gauge 10 for signals and 6 for points, are provided with adjusting screws, but compensation for temperature changes has not been adopted. Wheels, chains, pulleys and other details of the wire connections are the same for point as signal working. The maximum distance allowed for wire operated points is 1,500 feet and for those operated by rods 1,200 feet, but these figures are reduced where local conditions necessitate the use of angle wheels and cranks.

Crossing Places.

Crossing places on single lines, where an official is not on duty for trains-working, are termed interloops. On the main and more important branch lines, where there are fast services, two-way points indicators are provided at the facing points, each indication being given by a miniature arm, extending from a disc, the higher arm reading for the main line and the lower for the loop. Locking bars operating with the points are fitted. The point tumbler lever is key-locked and after being unlocked must be returned to the normal, or main line position before the key can be removed from the lock. At interloops on the lesser important branch lines no special provision as regards signalling is made and the security of the points is placed on the padlocking of the tumbler levers. This has been found satisfactory to cope with infrequent train services and slow speeds. Since tumbler levers are painted a distinctive colour, a driver of an approaching train has no difficulty in determining the position of the points. Warning boards, classified as fixed signals, placed 2,400 feet from the facing points, warn drivers of crossing-places ahead and afford protection.

Where a siding is situated in a main line section similar arrangements to those at an interloop are made, except that there is only one point indicator arm for the main line. Derails, compounded with the points, are provided on the siding to protect main line traffic.

At stations on lines where the train service is infrequent but local conditions justify some protection, a simple form of detector-locked signalling is provided. Home signals and, where justified, outer-home signals, operated from a centrally situated interlocked lever frame, are installed. Points which are hand-operated and bridle-locked are detected with the signals.

At stations where the speed of trains on the straight does not exceed 35 miles per hour, " interlocked " standard signalling is provided. All points on running lines (main or loops) are operated from the lever frame; facing points are furnished with economically operated locking bars and detectors for signals. Home signals and, where gradients permit, outer-home signals are in use.

Where the speed of trains on the straight is in excess of 35 miles per hour, the signalling is of the " interlocked special " type which has all the features of the " interlocked " type, but in addition the facing points on the main line are equipped with facing-point bolts, while distant signals are provided: the distant signal arm is placed on the same post as, but below, the outer-home signal.

Double line stations are generally of the " interlocked special " type and have starting and advance starting signals, with a single either-direction loop or separate loops, for up and down traffic.

Level Crossings.

Level crossings are protected by signs, flashlights or barriers—depending on traffic density—while the more dangerous crossings are being steadily eliminated by overhead bridges or subways, or occasionally by the deviation of roads. There are three types of road signs—the distant and two types of close-up signs. The distant sign is in the form of a St. Andrews cross picked out with white reflecting lenses and is placed 300 feet from the crossing. The close-up types have recently been re-designed to two patterns, the caution sign and the stop sign. The caution sign consists of an engine outline picked out with white lenses in a triangle with red lenses. The stop sign for busier crossings has the word " Stop " picked out in red reflecting lenses. Red flashlight signals are used at the busier crossings and are operated automatically by track circuits. Flashlights are erected at very busy level crossings on suburban lines where barriers are operated.

Train Control.

Some sections of single lines are controlled by the " telegraph order " system with a written authority for trainmen ; others operate with wooden staff and paper tickets ; but where traffic is denser, standard staff or tablet instruments are installed. There are a few sections operated as " Non-token " sections, where the line between the adjacent stations is track-circuited. Route signals control the entry of trains into these sections.

Working between double-line stations is on the " absolute " principle and the standard is " lock-and-block ". Since all signalling on the South African Railways is governed by two-stop signal practice, i.e., there must be not less than two stop signals between successive trains; a section commences at the starting or the advance starting signal of one station and terminates at the home signals of the station in advance. Within the limits of double-line stations, i.e., between the home and the advance starting signals, the area is free of the block instruments, but the running signals are track-circuit controlled and sequentially interlocked.

Electrical Signalling.

With the increase of traffic in certain localities, it became necessary to sub-divide the sections. At first this was accomplished by the use of motor operated semaphore signals but this method was abandoned eventually in favour of colourlight signals. The present standards for this working are :—

(1) The line from the advance starting signal to the home signals at the station in advance is track-circuited.
(2) The section is sub-divided by a main automatic signal showing red or green, preceded by an automatic distant signal.
(3) Both signals carry a small marker light in the form of an illuminated letter " A ", indicating that the signal is an automatic.
(4) Main automatic signals may be passed at danger after the train has been brought to a stand of not less than one minute.
(5) The advance starting signal at the station in rear is controlled by all track circuits up to the main automatic signal together with an overlap track circuit beyond of not less than 1,200 feet in length.

Where the traffic is intensive all intermediate sections are sub-divided and three-aspect colour-light signalling is provided both in sections and at stations. The stations may be switched out and the relevant signals then become entirely automatic in action, being distinguished by the customary illuminated letter " A ". Most running signals are of the three-aspect type, exhibiting red or yellow or green. The indications conveyed by these aspects are :—

Red—stop.
Yellow—proceed with caution, prepared to stop at the next signal.
Green—proceed, next signal yellow or green.

Where running movements are over a turn-out, the green aspect is not displayed, the proceed indication being given by the yellow aspect

only. Where movements past the signal can only be through a turn-out, two-aspect multiple-aspect (yellow or red) signals are used.

Long range route indicators are provided on main line running signals where diverging routes exist. Short range route indicators are provided on starting signals from dead ends or yards. Shunting movements are controlled by position light signals. These, at danger, exhibit two white lights in the horizontal position, and for " proceed ", two white lights at 45 degrees to the horizontal.

Running signals are controlled by all track circuits up to the next signal in advance together with an overlap track circuit beyond. Such signals detect all points which may lie between them and the next signal. All signals reading over points are stick-relay controlled and approach locking, route and indication locking are normal features. Route indicators do not exhibit an indication until the signal concerned has assumed the proceed aspect.

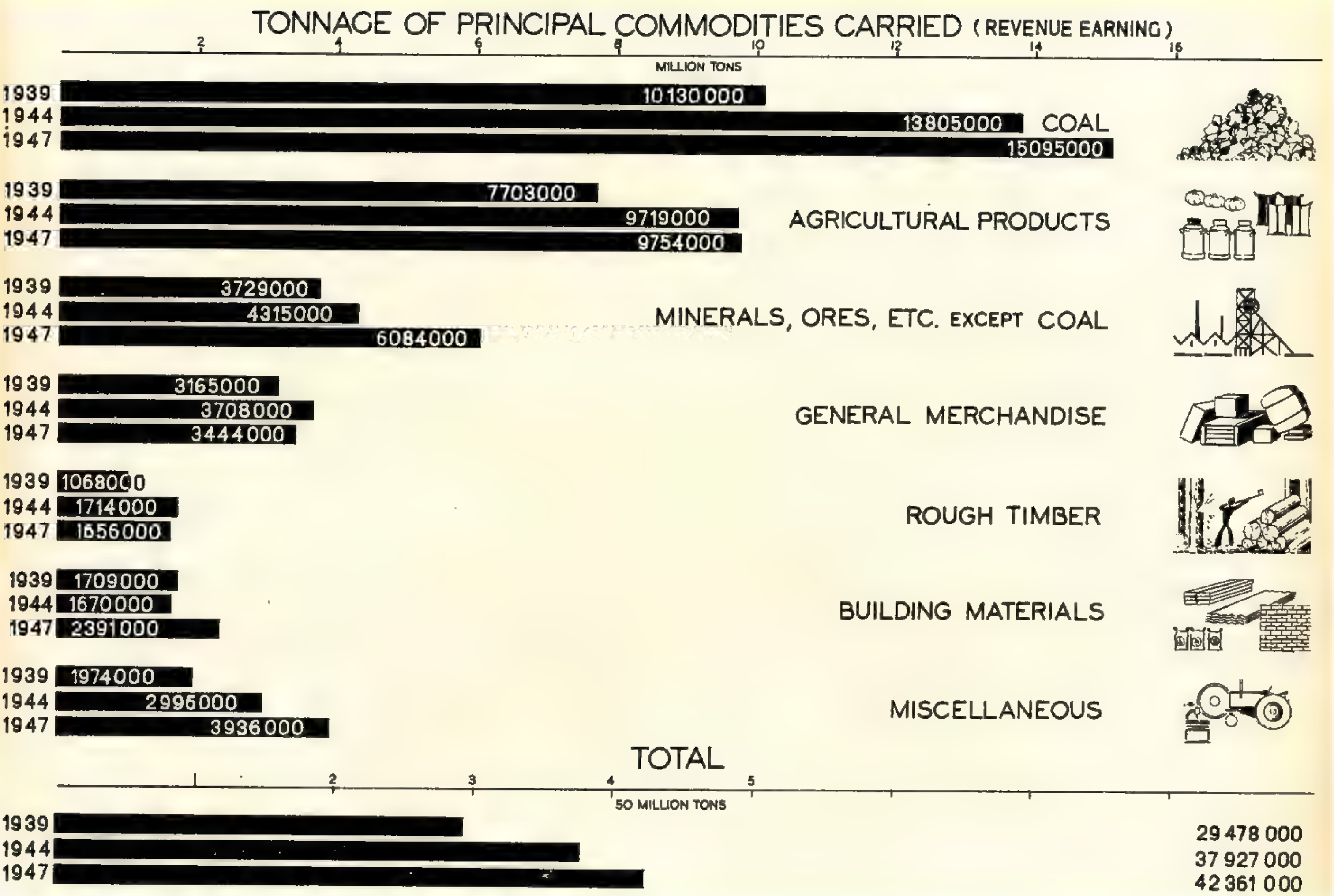
For all electric operation of points and signals lever frames with miniature type levers have been installed. The interlocking between levers is achieved electrically and check locking control of points levers is usually provided.

Route Relay Interlocking.

Whilst for power operated installations the all-electric type of lever frame is regarded as standard, three installations involving the use of Route Relay Interlocking principles have been installed. The indications are that this system may be used more extensively in the future since it results in speedy operation of functions with a minimum of operators.

Materials.

All mechanical signalling gear, except signal lamps, is manufactured in South Africa, either in the Railway workshops or by local factories. Electrical signalling gear is imported.



TONNAGE OF PRINCIPAL COMMODITIES CARRIED (REVENUE EARNING)
MILLION TONS
2
4
6
8
10
12
14
16
1939
1944
1947
10 130 000
13805000
15095000
COAL
7703000
9719000
9754000
AGRICULTURAL PRODUCTS
3729000
4315000
6084000
MINERALS, ORES, ETC. EXCEPT COAL
3165000
3708000
3444000
GENERAL MERCHANDISE
1068000
1714000
1656000
ROUGH TIMBER
1709000
1670000
2391000
BUILDING MATERIALS
1974000
2996000
3936000
MISCELLANEOUS
TOTAL
50 MILLION TONS
2
3
4
5
29 478 000
37 927 000
42 361 000

Chapter VIII

OPERATING

OPERATING THE UNION'S RAILWAY SYSTEM.

Special Features.

With no navigable rivers and with the interior guarded by mountain barriers situated a few miles from the sea and running parallel with the coast-line for almost its entire length, South Africa's commercial, industrial and agricultural economy is dominated by rail transport. The Railways are the only answer to the problems of long and heavy haulage. Imports have to be brought over mountain ranges and for great distances from the ports to the cities of the interior ; a diversity of climate promotes the cultivation of a wide variety of crops, a large proportion of which has to be conveyed to the ports ; and the principal mineral deposits, including coal, are located deep in the South African hinterland.

The discovery of diamonds at Kimberley, followed a few years later by the sensational gold finds of the Transvaal, supplied a direct impetus to the construction of railway lines. Up to that time, about 1890, development had been comparatively slow, but with the expansion of the goldfields, followed by the discovery of large coalfields in the Transvaal and in Natal, the need for an efficient railway network became at once more explicit and more urgent.

The Witwatersrand, by far the greatest gold-producing area of the world, and the Union's most highly-developed industrial region, has Africa's second-largest city, Johannesburg, as its metropolis.

Hence various special circumstances decided the trend of railway development, and the Union's railway system can be adequately described as either radiating from Johannesburg to the four major South African ports—Cape Town, Durban, East London and Port Elizabeth—and to the Portuguese port of Lourenco Marques, or as converging from these ports on Johannesburg, which is 500 miles from Durban ; 400 miles from the Portuguese port of Lourenco Marques ; 1,000 miles from Cape Town ; 700 miles from Port Elizabeth ; and 650 miles from East London.

It was indeed a fortunate circumstance that the greatest gold reef in the world should have been situated on the high African Plateau, where the climate is as pleasant and as healthy as any in the world, and in such a central situation relative to the sub-continent that the network of railways built to connect the gold mining area with the outside world, supplied the country immediately with a basic communication network covering almost the entire country.

The great coalfields of the Eastern Transvaal are only 90 miles from Johannesburg, regarded as a negligible distance in South Africa, while the main iron and steel-producing centres, Pretoria and Vereeniging, as well as the principal cement factories, are in close proximity.

Johannesburg, therefore, practically selected itself as the Headquarters of the Railway Administration. For purposes of administrative control South Africa has been divided into nine railway systems, each with its headquarters in the principal town within the area served.

Railway Resources.

At the end of 1946, the South African Railways were operating 13,949 route miles of railroad track, but only 420 route miles consisted of double track, and there was also a small

mileage of triple, quadruple and quintuple track. All the rest was single track.

The gauge operated is 3 foot 6 inch, which is uniform with that of South-West Africa and the Northern territories (Southern and Northern Rhodesia, Belgian Congo and Nyasaland) with which the Union has through rail links. There are also half-a-dozen narrow gauge (2 feet) branches still in operation in South Africa, but these are unimportant from the point of view of general operating phases. Narrow gauge construction is in any case not being perpetuated.

The form of traction generally employed is steam, but extensive sections are now electrified, notably that of the Natal main line from Durban to the Transvaal border at Volksrust, together with a branch which climbs the formidable Drakensberg (Dragon's mountains) on 1 in 30 grades, to reach the Orange Free State plateau at Harrismith ; the Witwatersrand-Pretoria area ; and the Cape Town suburban lines. Extension of the electrification system has in some cases already been authorised and in others it is contemplated.

At the end of 1946, the rolling-stock resources of the South African Railways comprised :—

- 2,339 steam locomotives with an aggregate tractive effort of 74,522,299 lb.
- 190 electric locomotives with an aggregate tractive effort of 3,989,950 lb.
- 2,666 main line passenger vehicles.
- 1,945 suburban passenger vehicles.
- 227 miscellaneous 3 foot 6 inch vehicles (coaching stock).
- 124 narrow gauge passenger vehicles.
- 58,110 open line merchandise-carrying vehicles (made up of 26,183 bogie and 31,927 short wagons) with an aggregate carrying capacity of 1,634,827 tons.
- 1,257 narrow gauge goods vehicles.
- 4,384 miscellaneous vehicles (goods stock, including local wagons, crane tenders, cabooses and breakdown vans).

Operating Control.

In surveying the operating organisation and the principles applied on the South African Railways, the enormous distances and the peculiar problems arising therefrom have to be borne in mind. From the northern extremity of the Transvaal to Cape Town is a distance of some 1,400 miles by rail, whilst 1,600 miles separate Johannesburg from Walvis Bay.

Control of the whole railway network is directed by the Chief Operating Manager, Johannesburg, while on each System control offices function under System Managers. In view of the distances involved, each system, with one exception, has a number of sub-control offices at strategic points. A comprehensive network of communications, utilising radio, teleprinter, telegraph and telephone, has been provided to link up Central Control with System Controls, System Controls with Sub-controls and Sub-controls with stations and depots on their respective sections.

Organisation.

The organisation of the Chief Operating Manager's office includes a Chief Superintendent Operating who is directly responsible for the activities of Central Control, which is sub-divided into the following sections whose designations more or less indicate the nature of their functions :—

(*a*) Truck Control and Distribution.
(*b*) Coaching Stock Control.
(*c*) Locomotive Control.
(*d*) New Rolling Stock.
(*e*) Timetables Section.
(*f*) Accidents and Regulations Section.
(*g*) Operating Research.
(*h*) Special Duties.

The basic functions of Central Control are :—

(i) The direction, supervision and co-ordination of all phases of traffic movement and ancillary activities throughout the Union and South-West Africa.

(ii) The regulation of inter-system movement of empty goods vehicles of the common or utility types, and the adjustment of losses or gains on Systems from day to day to provide for the volume of traffic offering.

(iii) The control of individual trucks falling under the category of " special types " for the conveyance of traffic the nature of which necessitates the use of specially designed containers, e.g., tank, refrigertor and explosives wagons and well-wagons for loads of abnormal dimensions, etc. These are styled " Unit Controlled " vehicles.

(iv) Unit control of all coaching-stock vehicles to meet the demand and general incidence of passenger traffic.

(v) The co-ordination of passenger train services and all matters affecting the provision of transport facilities for passengers.

(vi) The initiation of expenditure which may be necessary from time to time to increase the availability of truckage and power during peak periods and to regulate loadings when the necessity arises, with due regard to priority of traffic classes or the avoidance of congestion, etc.

(vii) Collaboration with all other sections of the Administration in connection with the provision of staff or facilities having a bearing on operating.

The System Control Officers are responsible for the maintenance of transport services on the Systems, an efficient and equitable distribution of truckage and engine power as between the various sections under their control, and the collation of all relevant data for the information of Central Control at Headquarters. The sub-control offices are usually situated at the larger towns or junction stations which, as a rule, are also the terminals of engine runs. Generally, the sub-control office is the direct contact with stations and depots and controls the detailed working, train services which, for the main lines, are diagrammed, supply of truckage and equipment, clearance of traffic and all other matters relating to the movement of traffic.

Passenger Traffic Features.

The predominating factor in the provision of passenger services is the traffic between Johannesburg and the ports and coastal resorts. Due to the variations in climatic conditions there are two accepted holiday seasons—the Cape and Natal—for the European population of the Witwatersrand and the interior generally. In each season the exodus reaches its peak with the school holidays, but there is now a tendency for the seasons to be extended. Natal draws visitors all the year round, while it is difficult to define the actual length of the Cape season. Hence main line passenger traffic is maintained at a fairly high level throughout the year between the inland provinces and the coastal belt.

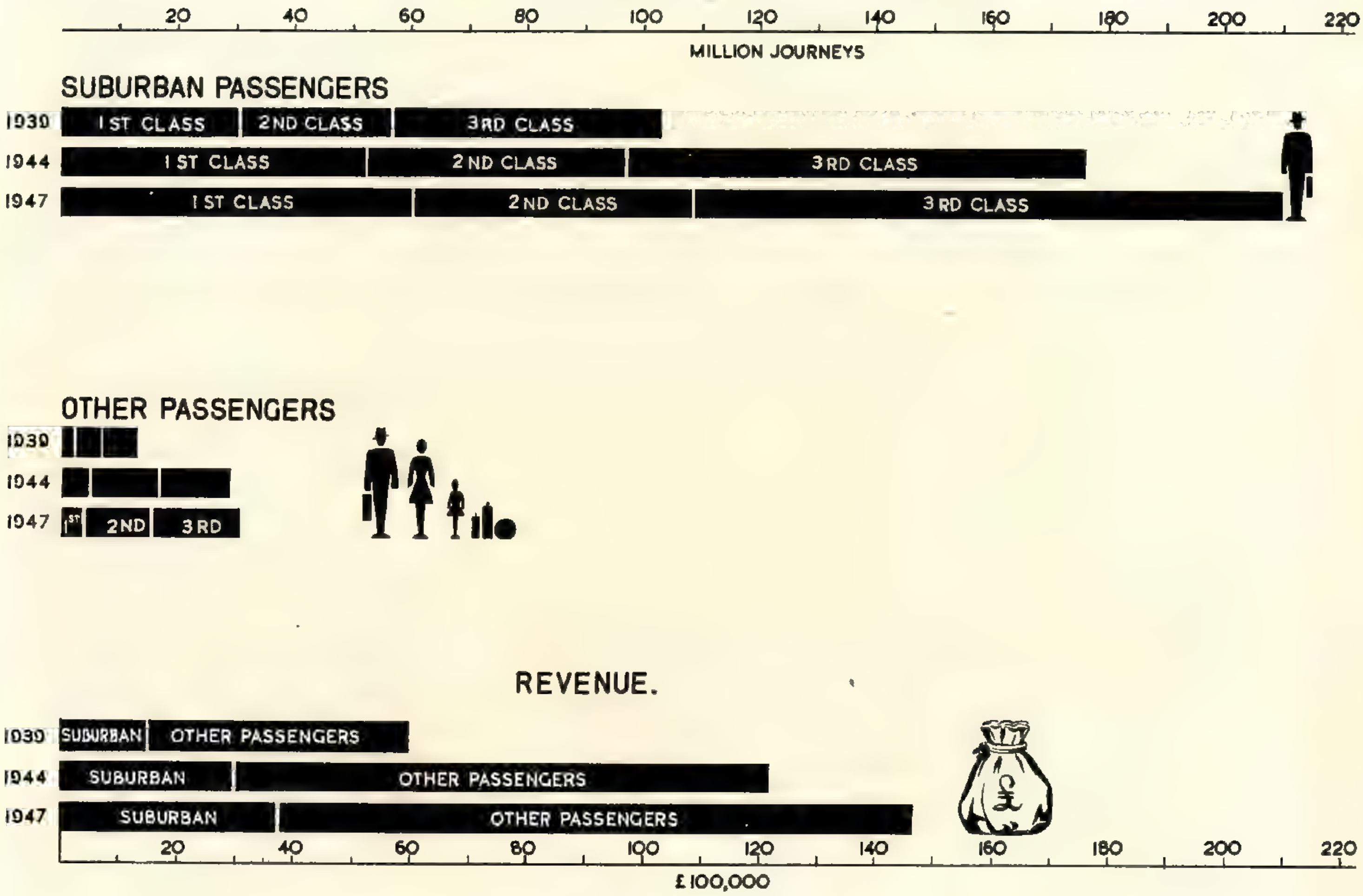
The intensity of the one-way flow of traffic during peak periods demands the running of empty coaching-stock trains in fast passenger timings in the reverse direction.

The average main line passenger train is composed of fifteen vehicles with a gross weight of 600 tons, which includes the baggage van and the dining and kitchen vehicles. On some sections, where the grades are easy, heavier trains are run, but, of the regular main line trains the heaviest single engine passenger load is the express de luxe " Blue Train " operated between Johannesburg and Cape Town. With drag from the air-conditioning plant, the gross weight of the " Blue Train " is equivalent to 700 tons, which for the 956 mile journey is hauled at an average running speed of 40·56 miles per hour. The journey includes the climb up the Hex River Mountains where curvature is severe and gradients of 1 in 40 uncompensated are negotiated.

Distribution of Mineral Wealth.

The Union is rich in minerals—its coalfields extending for many miles through the middleveld

PASSENGER JOURNEYS AND REVENUE.



of the Transvaal ; in the Free State ; and in Northern Natal. Large deposits of corundum, manganese, chrome, asbestos and lime occur in various parts of the interior. All have a direct influence on the operation of the Railway system, but coal production virtually dominates the picture. South Africa has become one of the major coal exporting countries of the world, and annual railings of coal now aggregate approximately 15,500,000 tons from Transvaal and Orange Free State collieries, and nearly 5,000,000 tons from Natal, giving a total of more than 20,000,000 tons per annum. The export and bunker coal trade absorbs approximately 5,000,000 tons a year, the balance being accounted for by internal, industrial and domestic use.

Some 15 to 18 per cent. of the output from the Transvaal collieries is exported through Lourenco Marques, the balance being distributed to all parts of the Union, except Natal. This results in a constant loss of truckage from the colliery areas, but since the preponderance of the traffic from the ports and other parts of the Union is for the Witwatersrand and to a lesser degree Pretoria, the daily deficit of truckage for the Transvaal collieries is made up by truckage released from the inladen traffic from these areas and light haulage is not of great consequence.

With the Natal collieries the export and bunker coal constitutes about 50 per cent. of the output. This passes through the port of Durban where a large portion of the empty truckage is absorbed by the import traffic. Unlike the Transvaal, there is little inladen traffic for the area about the Natal collieries and it is necessary to work empty truckage from other systems, involving empty hauls of up to 1,000 miles.

The necessity for opening up the country and developing its agricultural potential has also influenced Railway policy, resulting in the construction of a large number of branch and feeder lines. The country produces a wide diversity of crops, but there are seasonal variations which are particularly important from the railway-transport point of view, and which complicate operating control. Maize production, for instance, is concentrated in the Transvaal and the Orange Free State ; wheat is produced mainly in the Cape but also in the two northern provinces ; citrus fruit is one of the main crops of the Eastern Transvaal and of parts of the Cape Province ; Natal has its sugar-cane season ; and throughout the year the sub-tropical Eastern Transvaal demands a constant supply of trucks to move its fresh vegetables and its wide variety of fruits to the large urban markets.

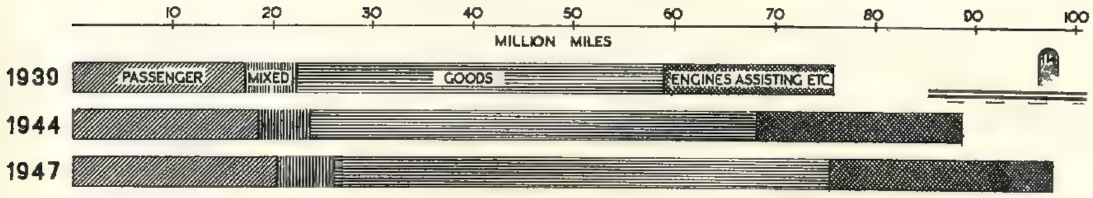
Maize is a good example of the special problems with which the Railways have to cope. It is grown chiefly in the Transvaal and the Orange Free State, and the crop, while averaging 2,200,000 tons a year, varies from 1,600,000 tons in bad years to 2,800,000 tons in a very good year. The threshing season precedes the rainy season by only a few months, and the maize crop has, therefore, to be moved with great promptitude.

In the transport of citrus to the pre-cooling storage plants at the ports and of bulk maize to the port elevators, block loads of wagons are worked to and from the ports as far as practicable since time, traffic intensity and other factors preclude the possibility of obtaining return loads.

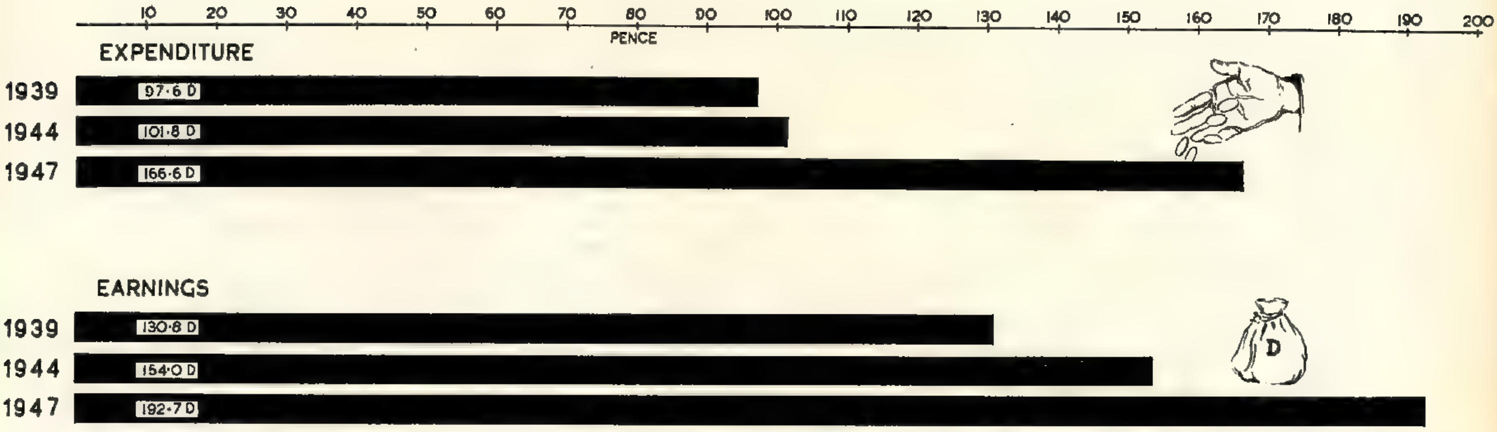
Sugar cane normally matures during the period May to October and is crushed at the sugar mills which are interspersed throughout the sugar cane area of the Natal and Zululand coastal belt. This entails short hauls for the conveyance of cane to the mills but, during the season, the service is intensive, approximately 2,500,000 tons of sugar cane being carried during that period.

Approximately seven million head of livestock, mainly sheep and cattle, are transported annually. A feature of this traffic is the heavy railings of cattle from South-West Africa to Union markets—notably Johannesburg and Cape Town, involving journeys of 1,800 miles.

ENGINE AND TRAIN MILES



GROSS WORKING EXPENDITURE AND TOTAL EARNINGS PER TRAIN MILE.



Livestock trains are run and arrangements are made for the animals to be rested, fed and watered at suitable stations en route to ensure their arrival in the best possible condition.

Advantage is taken of all opportunities of directing suitable types of truckage in such a way that return loads are obtained and light haulage restricted to the minimum. Much of the traffic handled by the South African Railways involves very long hauls and the question of return loads, therefore, assumes great importance and is one in regard to which constant vigilance and research are necessary.

On main line sections the loads of goods trains do not exceed 1,500 tons, although, with certain classes of engines, heavier trains can be hauled and trains with loads of 2,000 tons have been run. The loads are kept down to the lower figure to obtain a good average speed through sections.

On both the Orange Free State main line and the line from the Transvaal coalfields at Witbank to the Portuguese border, the traffic despatched in one direction over the single line has on occasions exceeded 23,000 tons. The daily gross tonnage conveyed between Witbank and the Witwatersrand frequently exceeds 50,000 tons and a tonnage of 56,661 has been reached. Twenty-three collieries are served by this line which, in addition, carries the heavy imports landed at Lourenco Marques for the Witwatersrand and the produce and citrus traffic from the lowveld area. The daily output of the collieries averages 39,500 tons per weekday and in a month aggregates over one million tons. It is a double-line section, 60 miles long, and is laid with 96-lb. track. The ruling gradient is 1 in 100 compensated with a maximum curvature of 4 degrees. The 15F class engine hauls a coal load of 1,470 tons for 100 axles, doing the 161 miles round trip between Germiston locomotive depot and Witbank in ten hours.

A feature of the coal traffic on this line is the working of hopper type wagons with capacities ranging from 40 to 68 tons. Their working is specially watched both at the colliery and the off-loading point and in this way it has been found possible to average four trips per week with these hoppers.

Engine working practice at the different depots varies according to the traffic demands but, except on branch lines and other feeder services where the traffic is light, engine pooling in some form or other has to be put into practice. On the majority of the main line sections " ring pooling " is in operation, a practice providing for an engine on arrival at a foreign depot being handed over to another crew who either work the train forward or return to the home depot with a load. For example :—

> On the run from Cape Town to De Doorns, 130 miles, the Cape Town enginemen book off at De Doorns where another crew takes over the engine to work a round trip from De Doorns to Touwsrivier, 63 miles. The engine is then worked back to its home depot by the rested Cape Town crew. A mileage of 323 miles is obtained as against the 260 miles if " ring pooling " were not resorted to.

On some runs extended engine runs are in operation, when an engine might be worked by four sets of enginemen before returning to its sheds. For example :—

> A Bloemfontein engine after the run to Kroonstad, 128 miles, will be taken over by another crew and be worked back to Bloemfontein. At Bloemfontein a fresh crew takes over for the run to Naauwpoort, 181 miles, from where the engine will be worked back to its home depot, Bloemfontein, by a fourth crew. The total mileage covered by the engine before returning to sheds is 618 miles.

The most extended engine run is that from Mafeking to Bulawayo, a distance of 484 miles. There are no intermediate engine depots and the trains are worked by two sets of enginemen with a caboose attached ; the one set resting in the caboose while the other is on the footplate.

Effects of the War.

The South African Railways are gradually recovering from the strain imposed on them during the years of war when new rolling stock, engines and other equipment were unprocurable. The replacement programme is very heavy and although considerable additions have been made to engine power and rolling stock in the last year, anxious years lie ahead. The pressure of traffic, arising from increases in population, expansion of industry and intensified agricultural production, is not expected to diminish. In order to meet anticipated requirements and to provide for the replacement of vehicles due for scrapping, a five-year purchasing and building programme has been adopted. This provides for the acquisition of :—

340	steam locomotives.
68	electric units.
245	electric suburban motor coaches.
480	suburban coaches.
1,002	main line coaches.
14,396	eight-wheeled wagons.
9,580	four-wheeled wagons.
220	narrow gauge wagons.

The present system of operating has successfully stood the searching tests to which it has been subjected, and the results achieved show that effective methods, born out of experience, have been evolved by the South African Railways to meet the transport needs of the Union.

ROAD MOTOR SERVICES.

When economic considerations brought railway construction to a temporary halt, the transport problems of the Union were by no means settled. The railway network was comprehensive enough to give a good operational basis, but vast areas of the country were without any form of regular, commercial transport. The European population—apart from the ports and a few large inland centres—was sparse and was spread thinly over the whole country, from the Atlantic to the Indian Ocean and from the Cape to the Limpopo River. Many of the outlying areas were potentially valuable as producers of foodstuffs and minerals, but could not support railways which were expensive to build and to operate.

The Railways had to solve the problem of bringing these outlying areas into the framework of the Union's economy, and the answer was found in National Road Motor Services, which have been established on a nation-wide scale under the control and direction of the South African Railways.

To-day these Road Motor Services have a route mileage of 22,000, of which 19,972 miles are in the Union and Swaziland, and 1,871 in South-West Africa, while 157 miles are operated for the Rhodesian Railways. The railway bus has become as familiar a sight in South Africa as the ox-wagon used to be, and it has inherited the latter's rôle as an instrument of rural development. It treks along dusty roads in all weathers ; stops at farms and wayside halts to pick up produce and often livestock ; it takes passengers from farm to town or railhead ; and it performs a multiplicity of tasks indispensable to the maintenance of modern living standards.

When other forms of transport had to be withdrawn from the roads during the war years because of petrol restrictions, an ever-greater share of the country's transport burden had to be shouldered by the Road Motor Services. The vehicles were old and were in many cases due for scrapping, new vehicles were unobtainable, and shortages affected them as they did every section of the population, but it was necessary for them to carry on, and they did so. Railway workshops started making spare parts—more than 500,000 different parts were manufactured in 1946—tyres and tubes were conserved as much as possible, and loads were increased. In one year 850,000 bags of maize and wheat were moved from farms to distributing centres.

The part played by these services in developing food production is illustrated by their record in

the vast area of the Northern Cape, where buses operate over distances of more than 200 miles. Cream traffic in the Kuruman and Vryburg districts now totals nearly 1,000,000 gallons a year, and the amount is steadily increasing. Large quantities of cream, milk, cheese and other farm products, are conveyed in all the provinces.

Cream, however, constitutes only a tithe of the farming produce conveyed by the Railways' road motor vehicles, which in 1946 carried 1,839,512 tons of goods, including grain, fruit, wool, mohair, skins, lucerne, tobacco and many other agricultural products.

Throughout the war years the public clamoured for additional services, but the introduction of these had to be delayed. Now, only a year after the war, expansion is being accelerated to meet the needs of the country. In the last twelve months 80 new services have been introduced, extending the route mileage by 2,626. Rural development services enjoy high priority in the Railway programme.

The Railway Road Motor Services, with 1,700 vehicles, have become the biggest organisation of their kind in the world. The only public transportation concern which has more road vehicles than the South African Railways is the London Passenger Transport Board, with 6,600 buses, but the conveyance of goods and livestock is not undertaken. The Greyhound Lines of the United States operate approximately 600 buses.

To the farmer the railway bus offers a solution to many problems. It takes him and his family at cheap rates to town or the railway station ; it conveys his children to and from school ; it takes his produce to market and brings seed, farm implements and fertilizers to his farm. To the transport-poor non-European it is equally important, since it carries him from his kraal to the railway station or from district to district in search of work.

The Railway Road Motor Services perform essentially pioneering duties, but before the present high standards of efficiency were attained there was a trial and error interlude. Bad roads throughout the country and the unreliability of motor engines before World War I forced railway engineers to improvise, and among the methods tried out was a steam tractor that could run on road or rail. The track was two foot gauge and of light material laid on the surface without any heavy earthworks. The experiment was a success but transport under these conditions was slow and cumbersome, and was abandoned when suitable motor vehicles became available. In 1925 the Government decided to embark on a large scale development of road motor services to facilitate the advancement of the more remote rural areas.

Service in some districts was held over for a considerable time until suitable robust vehicles could be acquired. The position was met by the use of the six-wheeled vehicles developed by the British War Office. These vehicles could go where the normal type could not be used. Improvements have followed until to-day vehicles are being operated with a carrying capacity of ten tons, capable at the same time of hauling trailer loads of from two to seven tons.

With the more robust type of vehicle road motor services grew apace, branching out on either side of the arterial railway lines. By 1936, 11,184 route miles of regular services were in operation with 433 vehicles covering 6,142,000 vehicle miles. The vehicle mileage increased to 28,766,000 last year (1946), while traffic conveyed showed equally spectacular increases—goods carried rose from 422,000 to 1,840,000 tons and passengers from 2,168,000 to 5,103,000.

In order to give private enterprise full scope, the Administration does not pioneer services until it is clear that private enterprise is not prepared to undertake the responsibility. When investigation indicates that a service may develop a particular area, a service is started with a dual purpose vehicle, usually capable of carrying five Europeans and eight non-Europeans, plus

five to seven tons of goods. This is the type of vehicle most commonly used in rural areas, while during heavier traffic periods a trailer is added.

In addition to the general utility services, three suburban services are operated and luxury services to meet the tourist trade are being introduced. These will be operated in conjunction with rail and air services as part of the policy to co-ordinate transport.

Chapter IX

HARBOURS AND SHIPPING

IN South Africa railway control and direction have brought the ports and harbours within the compass of the national transportation set-up, thus making possible the effective control and co-ordination of all transportation services. Through its Harbours and Shipping Section the Railway Administration provides for the maintenance of navigational channels, for buoys, lighting and lighthouses, tugs and pilotage, cranes and coaling appliances.

A single control of harbours has permitted of uniform harbour tariffs and regulations being applied to all harbours in the Union and South-West Africa. Before Union a cut-throat war was waged between the various ports competing for the rich trade to the diamond and coalfields, but Shipping and Commercial interests are now assured of uniform treatment and charges.

South African ports are not only important in relation to their situation on ocean routes but have developed under the impetus of the Union's remarkable growth as a food-producing, manufacturing and mineral-exporting country. The Railways have taken these factors into consideration in shaping harbour policy. New works have been undertaken ; docks have been enlarged ; graving docks have been built ; and powerful tugs, cranes and other harbour equipment have been provided. The four major commercial harbours in South Africa, Cape Town, Durban, East London and Port Elizabeth, offer safe and sheltered anchorage, plus all the facilities for handling ships in accordance with present-day standards.

Table Bay Harbour, the " Tavern of the Seas ", is the oldest harbour in South Africa and one of the most important in the Southern hemisphere, occupying a strategic position on the world's sea routes. At one time, owing to the lack of suitable accommodation for the berthing of large vessels, lighters played a major rôle in the handling of cargo and coal, but now Table Bay has three enclosed and equipped docks—the Victoria Basin, the Alfred Basin and the Duncan Dock, with a total acreage of 365, and a total length of quayage of 24,788 lineal feet—the foreshore has been reclaimed, and the port is adequately provided with sheds, cranes, and other equipment. Accommodation is available for the berthing and handling of the largest ships afloat, and approximately forty vessels can be worked alongside deepwater berths while an almost unlimited number of vessels can find shelter in protected anchorage.

Four powerful tugs and three pilot tugs are on duty at the port. All the larger tugs are fitted with wireless, modern salvage equipment and fire appliances. Ample shore cranage facilities are available ; the lifting-capacity ranges from 3 to 15 tons of 2,240 lb., plus a floating crane, capable of dealing with lifts up to 60 tons at 80 feet radius.

Two pre-cooling stores with a total capacity of 6,250 shipping tons and a grain elevator of 30,000 tons storage-capacity are available, while various oil companies have erected bulk oil storage and oil fuel tanks in the harbour area.

The Robinson Dry Dock in the Alfred Basin was for many years the only dry dock available in the Union to merchant shipping and, although still capable of rendering much useful service, has been eclipsed by the magnificent new Sturrock Graving Dock in the Duncan Dock,

which was opened in 1945 and is one of the largest in the world—with a length of 1,149 feet on keel blocks, a width at coping of 156 feet and a depth on entrance sill at L.W.O.S.T. of 40 feet. Table Bay Harbour is also equipped with a floating dock with a lifting-capacity of 450 tons.

Port Elizabeth, which was originally known as Algoa Bay, was the scene of the landing of the 1820 settlers. For many years the only berthing facilities at this port consisted of three jetties capable of accommodating only very small vessels. Cargo landed or shipped from ocean-going vessels had to be dealt with by means of lighters and passengers were transferred to or from launches by specially constructed baskets slung by the ship's derricks.

Despite the disadvantages of these conditions of working, Port Elizabeth served its immediate hinterland and the distant interior well for many years but in 1922 a start was made with the construction of a breakwater and jetty. Further construction followed and with the completion of the enclosed harbour Port Elizabeth was declared a pilotage port. The capital expenditure to date approximates £3,000,000.

The fine artificial harbour has an area of 314 acres with berthage for 17 deep-draught vessels and sheltered anchorage for seven more. In addition, anchorage is available for vessels of any draught in a partially sheltered roadstead. The total length of deep water quayage is 5,240 feet, and electric cranes with a lifting-capacity ranging from 4 to 15 tons are available. Besides the usual quay sheds, Port Elizabeth has a pre-cooling store with a storage-capacity of 4,500 shipping tons.

Two first class tugs, fitted with salvage pumps, fire appliances and wireless, carry out the normal working requirements of the harbour. A slipway, electrically operated and having a capacity of 1,200 tons, is available.

East London is the Union's only major river port. Its use as a berthage port was greatly restricted until comparatively recently by the existence of sand banks at the river's mouth and large ocean-going vessels were compelled to lie out in the roadstead. Passengers were handled by means of baskets as was done at Port Elizabeth.

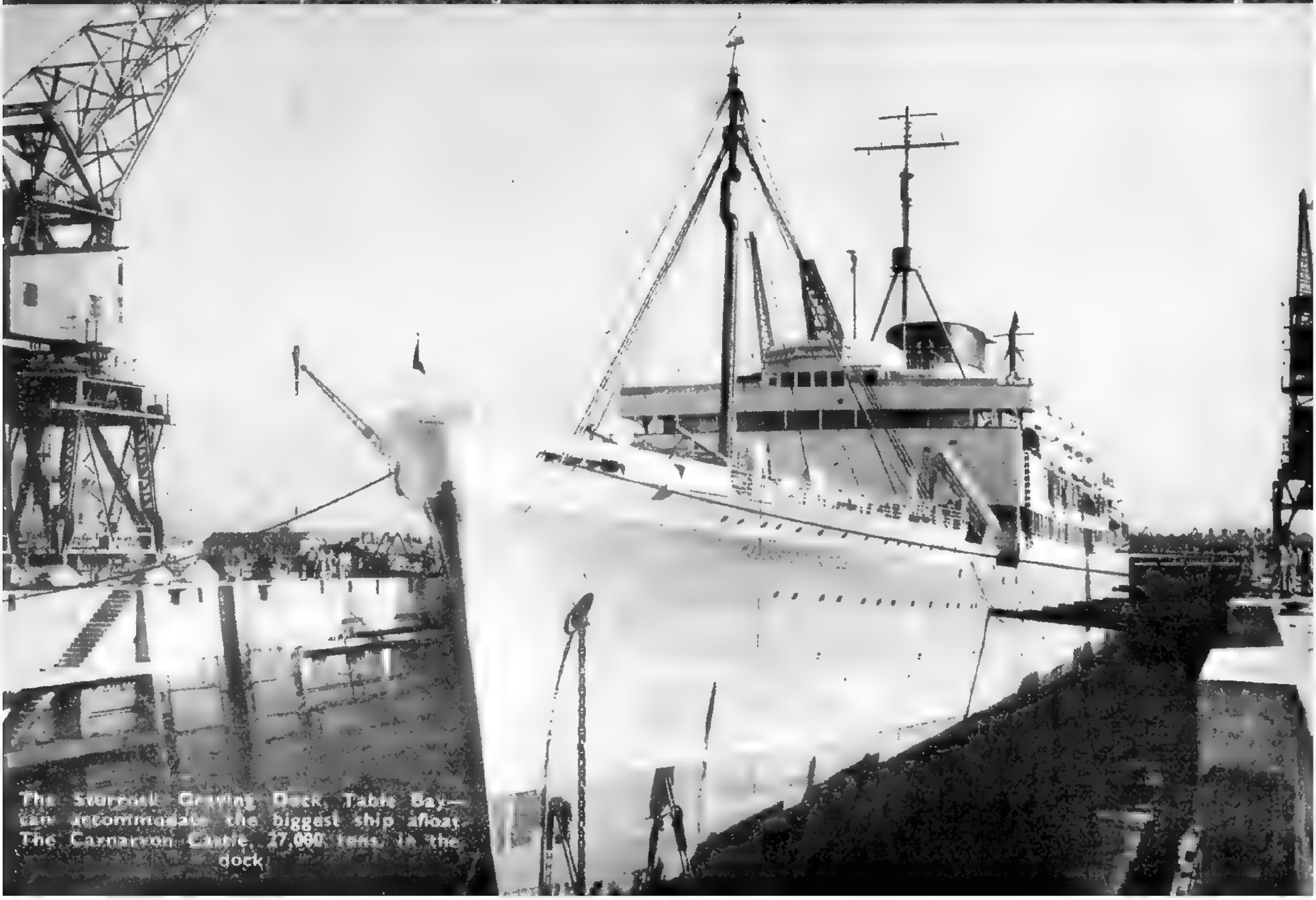
With the extension of the breakwater, the introduction of modern dredgers and the construction of a turning basin in the river, it has become a safe harbour, and all merchantmen regularly trading on this coast are able to enter and tie-up alongside completely equipped modern quays. A pre-cooling store with a capacity of 1,800 shipping tons is provided for the export of citrus and deciduous fruits. Eight bunkering points are available on the East bank for the delivery of oil fuel to vessels.

The most recent major development at this port is the completion of the Princess Elizabeth Graving Dock opened during March of this year by Her Royal Highness the Princess Elizabeth. Its measurements are: length, 686 feet 2 inches, width at copes, 89 feet 3 inches, and depth on sills at L.W.O.S.T., 33 feet 6 inches. In addition to the graving dock the port is provided with a slipway which can accommodate vessels up to 1,200 tons deadweight.

Durban, where £9,500,000 has been spent in providing harbour facilities and equipment, is one of the major ports of the Union by virtue of its geographical position, being the nearest Union port to the Witwatersrand goldfields and the coalfields of Natal. The landlocked bay which forms the harbour has an area of 4,122 acres, much of which used to be mangrove swamps. At one time it was shut off from shipping by a sandbar which could be crossed dry-foot, but to-day the working depth at the harbour entrance averages 42 feet at L.W.O.S.T. The largest vessels in the South African trade can now enter and leave the port at any state of the tide.

A new " T " jetty was recently constructed, providing five additional deep water berths. The total length of quayage is over 28,000 lineal feet and 90 cranes, with lifting-capacities varying from 3 to 80 tons, and a floating crane

Table Bay Harbour—showing Alfred Basin—the Duncan Dock and on extreme left, the Sturrock Graving Dock.



The Sturrock Graving Dock, Table Bay—can accommodate the biggest ship afloat. The Carnarvon Castle, 27,000 tons, in the dock.

"T" Jetty, Durban Harbour, Natal

of 25 tons lifting-capacity are provided for working cargo.

Durban is an important coaling station and is well equipped to handle the shipment of coal both for bunker and cargo purposes. The overhead storage bins have a capacity of 10,000 tons and on the ground there are concrete bins to store another 60,000 tons. The port has the largest grain elevator in the Union, having a storage-capacity of 42,000 tons. Provision has been made for the export of citrus and deciduous fruits through a pre-cooling store of 1,800 tons capacity. Oil fuel facilities are available but, as is the case at other ports, the bulk oil storage tanks are privately-owned.

The port has six powerful tugs fitted with wireless, modern salvage equipment and fire appliances.

Until the Sturrock Graving Dock at Table Bay was completed, Durban's Prince Edward Graving Dock, opened in 1925, was the largest in the Union. It is capable of accommodating some of the largest ships afloat, being 1,150 feet long, 110 feet wide at the entrance and 41 feet deep on sill at H.W.O.S.T.

Of the Union's secondary ports Walvis Bay in South-West Africa and Mossel Bay in the Cape are the most important and are engaged primarily on meeting the needs of the immediate hinterland they serve.

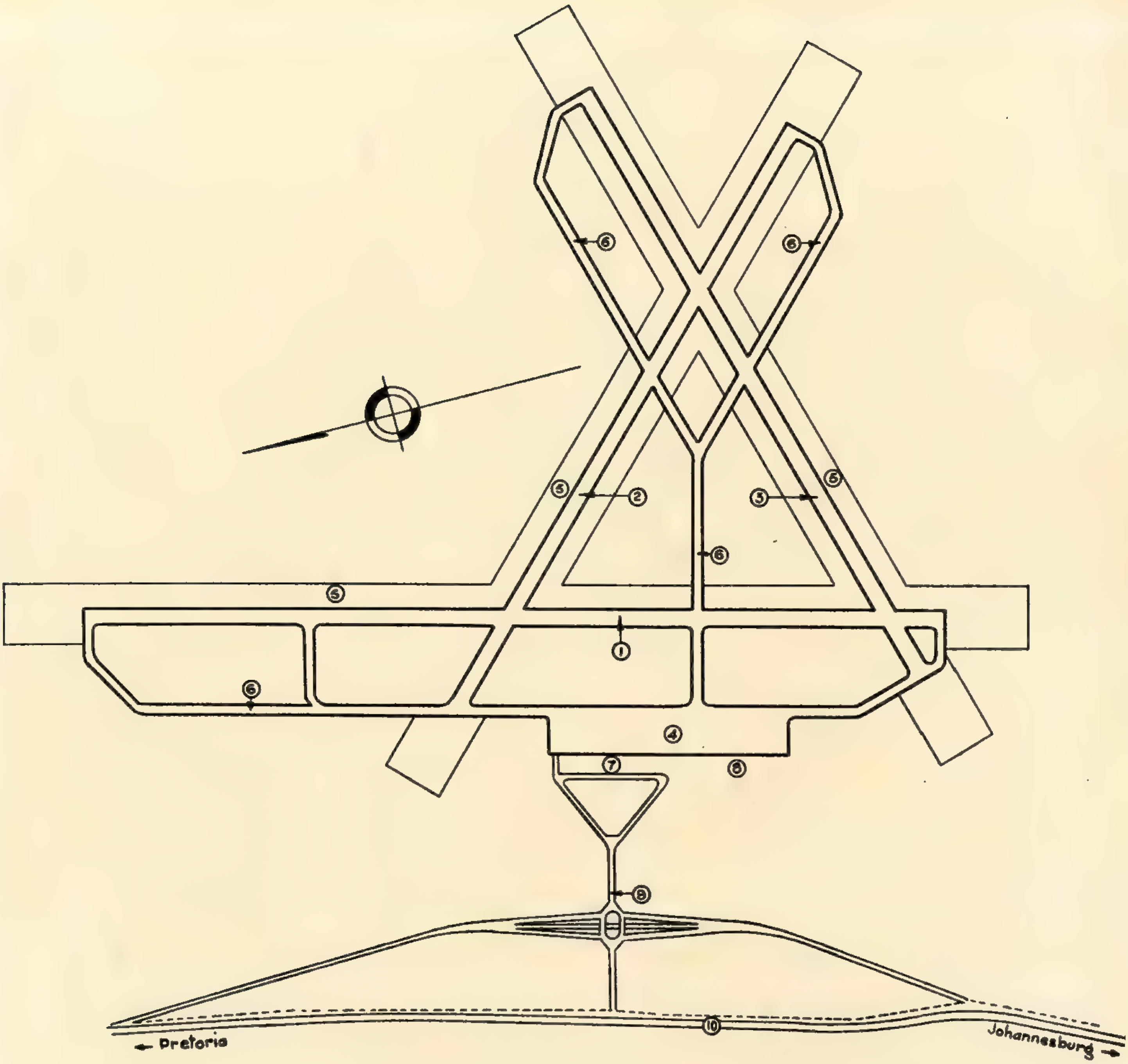
The total number of navigational aids on the Union and South-West African coast is 89. These comprise attended lighthouses, fixed lights, bell buoys, automatic flashes, radio beacons and fog signals.

SOUTH AFRICAN RAILWAYS' SHIPS.

In addition to auxiliary harbour craft, the South African Railways operate a mercantile fleet, which, prior to the war, comprised three deep-sea steamers. The fleet voyaged mainly to the Far East and Australia, conveying South African coal, together with small quantities of other products outwards, and returning with steel, timber, sleepers, flour and other products required in the Union.

During the war six prizes of war or requisitioned ships, chartered from the Union Government, were added to the fleet, which assisted in the transport of the Union's armed forces and their equipment to the Middle East, and took South African coal and other products to such destinations as Allied interests required.

The importance of having shipping space available for National and export needs is implicit in the Government's policy. The existing ships have grown old and costly to operate and approximately £1,400,000 has been set aside for the purchase of new ships. Railway ships have returned to their pre-war trade routes, but the West African Service, developed during the war, will be expanded as soon as practicable. With a growing fleet of cargo ships South Africa will have shipping space under its direct control.



LAYOUT OF SOUTH AFRICA'S INTERNATIONAL AIRPORT

1. Primary runway—3,500 yards long.
2. } Secondary runways—each 2,750 yards long.
3. }
4. Arrival and departure apron.
5. Gravel shoulders of runways.
6. Taxiways.
7. } Location of terminal buildings and hangars.
8. }
9. Airport Road.
10. Johannesburg-Pretoria Railway line. (Kempton Park station is approximately one mile north of airport.)

Chapter X

SOUTH AFRICAN AIRWAYS

BRIGHT skies, clear days, a general absence of fog conditions and long distances between the major centres—all help to encourage air travel in Southern Africa. Since February, 1934, when certain small-scale scheduled air services in the Union were taken over by South African Airways—a branch of the State-owned South African Railways—air services have expanded rapidly. To-day the air network covers the whole of Southern Africa and stretches north and east to other African territories, while the Springbok Service operates between South Africa and the United Kingdom.

At present South African Airways has a fleet of three 44-seater Skymasters, twenty 12-seater Lodestars, and two 27-seater Dakotas, and operates over a route mileage of 12,732, of which 4,900 miles represent local services, 953 miles regional services to neighbouring territories, and 6,879 miles the Springbok Service between Johannesburg and London. The latter is a joint venture in which the South African Airways and the B.O.A.C. are associated on a partnership basis. Palmietfontein airport, near Johannesburg, is the temporary southern terminus of all foreign passenger-carrying aircraft, South African Airways taking over from this point.

The demand for passenger accommodation on aircraft is still expanding and South African Airways now propose adding three D.C. 4 (Skymasters), eight Vikings and some smaller aircraft to their fleet.

The passenger mileage recorded by South African Airways in 1946 was 35,000,000 as compared with 4,000,000 in 1936, while fare-paying passengers increased from 15,315 to 69,065 in the same period. It is worthy of note that since the resumption of civil flying in the Union in 1944, South African Airways have maintained an accident-free record, in respect of both passengers and air-crews.

South African Airways could not operate during the war since the Union Government—the only Dominion Government to do so—completely suspended all civil aviation in 1940. The aircraft of South African Airways were all transferred to the Department of Defence and most of the personnel volunteered for active service. It was not until December, 1944, when the war had taken a favourable turn, that scheduled air services were resumed, and then only on a restricted basis. Only six aircraft were initially made available by the Department of Defence and for a considerable time a skeleton service only could be maintained. Available seating capacity could not measure up to public requirements, but the position is now substantially better, though not entirely satisfactory.

As the outcome of the Southern Africa Air Transport Conference held in Cape Town in March, 1945, and subsequent negotiations, agreement was reached for establishing a trunk air route between South Africa and Great Britain, to be operated jointly by South African Airways and British Overseas Airways Corporation. Accordingly, in November, 1945, the Springbok Service with Avro York aircraft was started between Johannesburg and London. To meet the demands for accommodation on the Springbok route, the service was temporarily supplemented in July, 1946, by a Skymaster of the South African Airways fleet. At present six return services a week are flown in each

direction, in addition to a Skymaster service three times a month. It is the intention to build up the capacity of this route to 250 seats a week in each direction, and to this end additional Skymasters are being purchased by South African Airways. It is hoped by next year to operate Skymaster services on three days a week and British Overseas Airways Corporation Solent flying boats on four days per week.

The increased size, speed and weight of aircraft used on the air services have necessitated the construction of airports to standards which meet the exacting demands of present-day civil aircraft. The Railway Administration is building an international airport midway between Pretoria and Johannesburg, to be known as " The Jan Smuts Airfield ", while two major national airports are in the course of construction at Cape Town and Durban. Palmietfontein, near Johannesburg, is serving as a temporary international airport.

To ensure that the latest ideas in airport design and construction and ancillary revenue-producing facilities are incorporated in these airports, officers were sent to the United States to study traffic conditions and aerodrome layouts. " Jan Smuts Airfield " situated at an altitude of about 5,500 feet will have hardened runways designed to accommodate aircraft of a total weight of 300,000 lb. The main runway will be 10,500 feet long, and each of the two auxiliary runways will be 8,250 feet long, with paved widths of 200 feet, while the gradient of the approach zone will be 1 in 50. The national airports at Cape Town and Durban are being built to take aircraft with a weight of 150,000 lb., and will have main runways 6,600 feet long, with a paved width of 200 feet and auxiliary runways 5,280 feet long, with a paved width of 150 feet. While a commencement has been made with the construction of these airports, in view of the magnitude of the work and engineering difficulties involved, it will be some years before they are completed.

In order to improve intermediate aerodromes on the internal routes operated by South African Airways, hardened runways, in addition to the necessary lighting and radio aids and communications, are to be built by the municipalities concerned.

MINISTER, GENERAL MANAGER AND SENIOR OFFICFRS.

MINISTER OF TRANSPORT.

The Hon. F. C. Sturrock, M.P., M.I.M.E., M.Inst.T.

RAILWAYS AND HARBOURS BOARD.

Chairman............................	The Hon. F. C. Sturrock.
Railway Commissioners................	Mr. F. T. Bates Mr. J. D. P. Fourie. Mr. W. R. F. Teichmann.

RAILWAY SERVICE COMMISSION.

Chairman............................	Mr. J. H. Stewart.
Members.............................	Mr. S. P. Havenga. Mr. E. A. Bambury, M.I.L.E.. A.M.I.M.E.

GENERAL MANAGER.

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Deputy General Manager..............	Mr. W. Heckroodt, M.Inst.T.
Chief Technical Manager.............	Mr. E. H. Wilson, B.A., B.Sc., A.M.I.C.E.
Chief Harbours, Shipping and Development Manager	Mr. D. H. C. du Plessis.
Chief Commercial and Industrial Manager	Mr. D. M. Robbertse, M.Inst.T.
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Chief Airways Manager................	Major-General C. J. Venter, *C.B.*, *D.F.C.* (Bar).
Chief Mechanical Engineer............	Dr. M. M. Loubser, D.Sc., B.A., M.I.L.E.
Chief Civil Engineer.................	Mr. J. S. de V. von Willich, B.Sc., A.M.I.C.E.

PRINCIPAL RAILWAY STATISTICS.

	March 31—			December 31—	
	1947.	1935.	1925.	1915.	1910.
Total expenditure on capital account (open lines)..............£	199,219,335	149,871,077	118,366,441	86,990,040	75,100,228
3 foot 6 inch gauge—					
Total route mileage of open lines....................Miles	12,537	12,341	10,618	8,404	6,660
Locomotives, steam..................................No.	2,293	2,051	1,797	1,549	1,405
Locomotives, electric................................No.	188	95	—	—	—
Locomotives, Diesel.................................No.	2	—	—	—	—
Coaching vehicles...................................No.	4,865	3,678	3,060	2,572	2,080
Goods stock, excluding cranes........................No.	63,339	39,670	33,326	27,331	22,576
2 foot gauge—					
Total route mileage of open lines....................Miles	793	884	910	520	380
Locomotives, steam..................................No.	59	65	65	44	25
Coaching vehicles...................................No.	131	125	114	91	72
Goods stock, excluding cranes........................No.	1,263	1,031	914	418	259
Total tractive effort of all locomotives.......................lb.	79,269,519	61,576,011	47,116,031	36,219,692	28,399,132
Carrying capacity of goods stock...........................Tons	1,659,052	929,686	694,030	526,067	390,896
Train mileage...Miles	75,727,282	46,713,496	40,262,785	29,768,631	23,580,646
Train and engine mileage................................Miles	97,834,009	59,724,596	50,929,573	36,938,433	29,764,137
Passenger journeys.......................................No.	240,841,262	83,280,993	70,832,189	43,800,230	33,700,849
Tonnage of goods and minerals other than coal (revenue earning) Tons	27,266,695	15,371,406	9,054,403	5,763,616	10,708,737
Tonnage of coal (revenue earning)..........................Tons	15,095,140	8,414,170	9,736,403	6,275,828	
Tonnage of railway stores and coal.........................Tons	6,836,113	4,123,569	4,026,254	Not available	1,706,102
Gross tonnage of goods carried............................Tons	49,197,948	27,909,145	22,817,060	12,039,444	12,414,839
Livestock carried, large and small.........................Head	7,103,693	3,295,127	3,278,366	Not available	2,733,990
Earnings—					
Passengers..£	13,682,885	4,907,899	5,090,351	3,888,887	3,189,474
Parcels...£	1,585,443	601,189	556,450	—	—
Mails...£	212,326	178,845	141,764	—	—
Goods...£	35,566,779	16,664,473	10,733,371	5,651,294	6,274,395
Coal..£	6,427,453	3,328,521	3,999,354	1,776,100	2,017,130
Livestock...£	1,456,795	568,198	574,582	596,983	384,802
Miscellaneous...£	1,878,480	772,690	651,759	284,626	291,937
TOTAL EARNINGS..............................£	60,810,161	27,021,815	21,747,631	12,197,890	12,157,738
Expenditure—					
General charges...£	1,337,346	466,027	350,200	381,244	564,955
Maintenance of permanent way and works.................£	7,996,859	2,492,607	2,728,046	1,578,473	1,880,814
Maintenance of rolling stock............................£	8,182,268	3,634,914	3,763,604	1,469,230	1,197,710
Running expenses..£	11,578,342	4,590,984	4,028,371	2,068,563	1,641,247
Traffic expenses..£	12,472,499	3,894,116	3,793,038	1,793,104	1,378,164
Superannuation..£	1,531,152	815,746	325,205	—	—
Cartage...£	1,148,162	434,924	370,107	208,692	—
Depreciation..£	2,005,512	2,011,904	1,500,000	363,336	—
TOTAL WORKING EXPENDITURE................£	46,252,140	18,341,222	16,858,571	7,862,642	6,662,890
Other miscellaneous receipts and charges (nett)...............£	Dr. 9,118,985	Cr. 369,552	Cr. 79,747	Dr. 118,816	71,057
Interest payable on capital.................................£	6,079,548	5,161,420	4,147,882	2,906,052	2,401,143
Profit and loss...£	Dr. 640,512	Cr. 3,888,725	Cr. 820,925	Cr. 1,310,380	Cr. 3,064,762
Average per train mile—					
Earnings..	16s. 0·7d.	11s. 6·8d.	10s. 9·6d.	8s. 2·3d.	10s. 3·7d.
Expenditure...	12s. 2·6d.	7s. 10·2d.	8s. 4·5d.	5s. 3·4d.	5s. 7·8d.
Average per open mile—					
Earnings..£	4,562	2,047	1,914	1,398	1,757
Expenditure...£	3,470	1,389	1,483	901	963
Ratio of expenditure to earnings...........................%	76·06	67·88	77·5	64·5	54·80

HARBOUR STATISTICS.

	March 31—			December 31—	
	1947.	1935.	1925.	1915.	1910.
Capital cost—all harbours....£	28,237,857	16,750,151	13,202,701	12,326,915	11,438,912
Vessels handled—					
Number....No.	7,221	5,496	4,725	3,625	4,376
Gross tonnage....Tons	24,495,241	31,308,134	22,751,552	14,612,344	18,979,028
Cargo handled—					
Landed....Harbour Tons	6,170,502	3,655,987	2,753,810	2,137,606	2,450,424
Shipped....Harbour Tons	4,290,471	3,728,095	4,360,802	2,751,674	2,645,514
Transhipped....Harbour Tons	126,169	36,397	24,217	37,518	17,125
TOTAL....Harbour Tons	10,587,142	7,420,479	7,138,829	4,926,798	5,113,063
Earnings....£	3,962,148	1,560,713	1,375,046	966,360	—
Gross working expenditure....£	1,747,085	703,290	603,187	680,829	—
Profit and loss after meeting all charges including interest....£	Cr. 984,593	Cr. 307,357	Cr. 368,764	Dr. 124,952	—
Staff of South African Railways—all services....No.	177,964	90,561	92,372	61,341 with 4,489 in South-West Africa.	54,752

OPERATING STATISTICS.

	1947.	1940.	1935.
Freight Ton Mileage.			
Goods and minerals (excluding coal)....Ton Miles	6,412,946,303	5,025,049,188	3,058,906,178
Coal....Ton Miles	3,617,717,386	2,326,603,577	1,837,570,185
Livestock....Ton Miles	219,280,069	130,414,811	86,948,115
Total revenue earning traffic....Ton Miles	10,249,943,758	7,482,067,576	4,983,424,478
Free hauled coal and stores....Ton Miles	2,364,247,509	1,996,586,386	1,441,261,452
Total freight ton miles....Ton Miles	12,614,191,267	9,478,653,962	6,424,685,930
Average Length of Haul.			
Goods and minerals (excluding coal)....Miles	235	227	199
Coal....Miles	240	231	218
Livestock....Miles	306	346	310
Total revenue earning traffic....Miles	238	229	207
Free hauled coal and stores....Miles	346	322	350
All traffic....Miles	253	244	228
Average net load of goods trains....Tons	240	224	211

AIRWAYS STATISTICS.

	For Year Ending March, 31—		
	1947.	1939.	1935.
Passengers .... No.	82,839	31,912	8,938
Freight .... lb.	154,000	180,366	67,795
Mails .... lb.	2,646,000	2,448,046	41,456
Luggage .... lb.	3,466,012	1,246,110	276,711
Mileage flown .... Miles	5,123,427	1,451,453	522,257
Passenger mileage .... Miles	97,845,600	9,278,338	2,319,538
Staff .... No.	1,427	386	101

Note.—Airways did not function during war, recommenced services from 1/12/1944.

AIRWAYS REVENUE AND EXPENDITURE.

	For Year Ending March, 31—		
	1947.*	1939.	1935.
Revenue.	£	£	£
Passengers	1,231,506	151,876	16,234
Mails	421,729	77,602	4,916
Freight	129,014	4,711	1,279
Miscellaneous	7,744	759	10
TOTAL .... £	1,789,993	234,948	22,439
Expenditure.	£	£	£
Superintendence	107,100	7,832	5,335
Air station expenses	—	37,186	4,362
Running expenses	—	144,139	13,750
Repairs and upkeep	—	134,083	11,177
Agency fees	55,462	6,454	540
Advertising	4,113	6,406	1,460
Insurance	40,718	40,814	7,519
Miscellaneous expenditure	—	10,842	690
Depreciation	—	124,606	9,687
Aircraft operations	919,829	—	—
Ground operations	318,156	—	—
Railage and passenger fares	15,571	—	—
Superannuation	17,650	—	—
Other Expenses	20,712	—	—
TOTAL .... £	1,499,311	512,362	54,520

* Method of Accounting Changed from 1/4/46.

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